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U.S. DEPARTMENT  
OF AGRICULTURE

FOREST SERVICE

ROCKY MOUNTAIN REGION

# AIR RESOURCE MANAGEMENT PROGRAM ASSESSMENT



Air pollution can travel long distances to impact sensitive wilderness components such as pristine mountain views, lake chemistry, lichens, and a host of other resources.



12 NOV 1992



#### ACKNOWLEDGMENTS

*This document was created as a team effort by individuals throughout Region 2 of the Forest Service. This group included the following: Dennis Haddow, Regional Office; Tamara Franklin, Regional Office; Les Dobson, Rio Grande NF; Kirk Wolff, Routt NF; Malcolm Edwards, Medicine Bow NF; and Kathy Foster, San Juan NF.*

*Input and feedback for the "Priority Assessment" section of this document was also provided by Dan Ely and Jim Geier of the Colorado State Health Department - Air Pollution Control Division, and by Bernie Daly of the Wyoming Department of Environmental Quality - Air Quality Division.*

*Helpful editing comments on an earlier draft of this document were made by John McCarthy, White River NF; Robert Sprentall, Nebraska NF; Christie Gordon, Pike & San Isabel NF; and Scott Maki, Shoshone NF.*

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## ROCKY MOUNTAIN REGION

### AIR RESOURCE MANAGEMENT PROGRAM ASSESSMENT

#### TABLE OF CONTENTS

<b>Chapter 1: Purpose of Plan.....</b>	<b>1</b>
Purpose.....	3
Format.....	3
<b>Chapter 2: Opportunities and Legal Responsibilities for Protecting National Forests from Air Pollution Impacts.....</b>	<b>5</b>
Introduction.....	7
The Federal Clean Air Act.....	7
The Wilderness Act.....	9
Wilderness Air Resource Management Philosophy.....	10
Other Land Management Acts.....	11
Protecting Class II Wilderness and Non-Wilderness.....	11
Control of Pollutants from Forest Service Land Management Activities.....	12
The Prevention-of-Significant-Deterioration Permit Process.....	12
Colorado PSD Permitting Program.....	12
Wyoming PSD Permitting Program.....	14
Forest Service PSD Permit Recommendations.....	15
Program Analysis.....	16
Summary.....	16
Table 2-1: Allowable PSD Increments.....	18
Table 2-2: Air-Quality-Related Values and Potential Air-Pollution- Caused Changes.....	19
Table 2-3: Colorado Wilderness Areas Administered by Rocky Mountain Region, Forest Service.....	20
Table 2-4: Wyoming Wilderness Areas Administered by Rocky Mountain Region, Forest Service.....	22
Table 2-5: South Dakota Wilderness Areas Administered by Rocky Mountain Region, Forest Service.....	23
Table 2-6: Nebraska Wilderness Areas Administered by Rocky Mountain Region, Forest Service.....	23
<b>Chapter 3: Priority (Risk) Assessment.....</b>	<b>25</b>
Introduction.....	27
The Background and Purpose of Priority Assessment.....	27
Airsheds.....	27
The Matrix Combination Process.....	27
Table 3-1: An Example of the Matrix Combination Process.....	29
Table 3-2: How Emissions Trend and Available Info Are Combined.....	30
Table 3-3: How Resource Trend and Resource Sensitivity Are Combined.....	31
Assumptions.....	32

Results of the Priority-Assessment Process: Region 2 Airshed Summaries.....	33
Bighorn Airshed.....	33
Canon City Airshed.....	33
Four Corners Airshed.....	34
Front Range Airshed.....	34
Granby Airshed.....	35
Grand Junction Airshed.....	35
Greater Yellowstone Airshed.....	36
Gunnison Airshed.....	37
La Junta Airshed.....	38
La Sal Airshed.....	38
Medicine Bow Airshed.....	38
Plains Airshed.....	39
Red Desert Airshed.....	40
Thunder Basin Airshed.....	40
Wheatland Airshed.....	41
Priority Assessment Summary.....	41
Forest Uses for Priority Assessment.....	41
Regional Office Uses for Priority Assessment.....	41
Monitoring Recommendations.....	42
Staffing Recommendations.....	43
Appendix 3-1a: Region 2 Airshed Overview.....	44
Appendix 3-1b: Region 2 Airsheds: Wyoming Area.....	45
Appendix 3-1c: Region 2 Airsheds: Colorado Area.....	46
Appendix 3-1d: Region 2 Airsheds: Plains Area.....	47
Appendix 3-2: Pollution Sources Potentially Affecting R2 Wilderness Areas.....	48

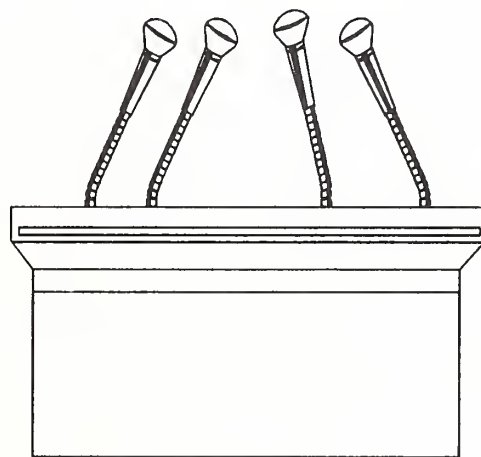
#### Chapter 4: Region 2 Air Resource Monitoring.....49

Introduction.....	51
Establishing a Forest Monitoring Program.....	52
Monitoring the Air Pollution Impacts of Fire.....	53
Terrestrial Ecosystems.....	53
Lichen.....	53
Vascular Plants.....	54
Recommended Priorities from the Estes Park Screening Meeting:	
Terrestrial Ecosystems.....	55
Aquatic Ecosystems.....	55
Flora and Fauna.....	56
Plankton.....	56
Amphibians.....	56
Soils.....	57
Water.....	57
Lake and Stream Chemistry.....	58
Snowpack Chemistry.....	59
Snowmelt.....	59
Recommended Priorities from the Estes Park Screening Meeting:	
Aquatic Ecosystems.....	59
Visibility.....	60
View Monitoring.....	61
Atmospheric Optical Monitoring.....	61
Particle Monitoring.....	61
Recommended Priorities from the Estes Park Screening Meeting:	
Visibility.....	62

Supporting Information: Atmospheric Deposition and Meteorology.....	62
Footnotes.....	64
Appendix 4-1: Critique of ANC Models.....	68
Table 4-1: Region 2 Existing Air-Quality-Related Value and Air-Chemistry Monitoring.....	70
<b>Chapter 5: Training and Expertise Needed for Air Resource Specialists.....</b>	<b>75</b>
Introduction.....	77
Working-Level Knowledge.....	77
GS-5 Trainee.....	78
GS-7 Advanced Trainee.....	78
GS-9 Air Specialist.....	79
GS-11 Air Specialist.....	79
GS-12 Air Specialist.....	80
GS-13 Air Specialist.....	81
Developmental Training for Air Resource Specialists.....	81
Additional Training Recommendations.....	82
Appendix 5-1: Air Resource Information Sources.....	83
<b>Chapter 6: Limits of Acceptable Change for Sensitive Receptors.....</b>	<b>87</b>
Introduction.....	89
Visibility.....	90
Aquatic Ecosystems (Lakes and Streams).....	91
Terrestrial Ecosystems.....	93
<b>Chapter 7: Data Management, Analysis &amp; Reporting.....</b>	<b>97</b>
Introduction.....	99
Atmospheric Deposition.....	100
Visibility.....	100
Particulate Sampling.....	101
Surface Waters - Lake Chemistries.....	101
Aquatic Biota: Plankton & Macroinvertebrates.....	102
Terrestrial Biota: Lichens.....	102
<b>Chapter 8: Air Resource Management Glossary.....</b>	<b>103</b>



# PURPOSE OF PLAN





## CHAPTER 1: PURPOSE OF PLAN

### PURPOSE

The Rocky Mountain Region of the USDA Forest Service comprises 17 National Forests and seven National Grasslands in Colorado, Wyoming, Nebraska, and South Dakota. These contain sensitive ecosystems and spectacular scenery which can be harmed by existing and future air pollution. To minimize or prevent such damage, the Region has created this Air Resource Management Program Assessment. Its basic purpose is to ensure that the Region's most sensitive ecosystems will be identified and protected. Also, by helping to coordinate air resource management activities between Forests, we hope to minimize unnecessary duplication of effort.

More specifically, the intent of this Assessment is to:

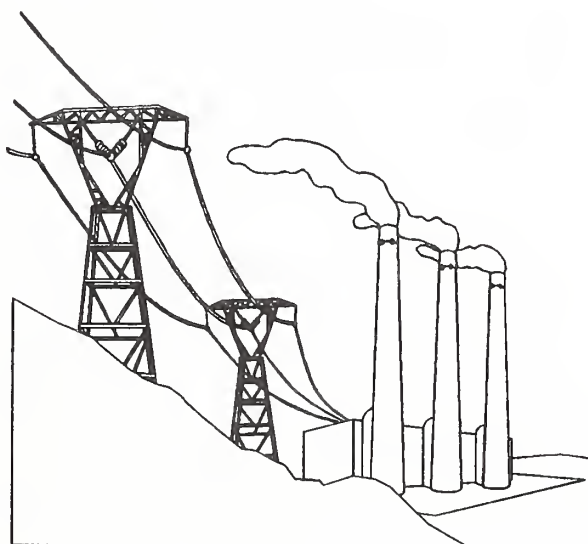
1. Explain the short-term objectives, long-range goals, and overall philosophy of air resource management.
2. Review the Forest Service's opportunities and legal responsibilities regarding resource protection from air pollution.
3. Evaluate actual and potential air pollution threats to all National Forest System (NFS) lands within the Region.
4. Identify the ecosystems on NFS lands within the Region which are most sensitive to air pollution.
5. Establish monitoring programs to detect or predict changes in forest ecosystems caused by air pollution.
6. Define the "limits of acceptable change" relative to air pollution impacts on various components of forest ecosystems.
7. Determine the training and skills needed for air resource management at each organizational level of the Forest Service.
8. Discuss current data management systems for the storage and analysis of air program data.
9. Considering 1-8 above, prioritize the Region's funding and personnel needs in air resource management.

### FORMAT

This Assessment begins with an explanation of its purpose, followed by a summary of the principles, laws, and regulations relating to resource protection from air pollution which involve the Forest Service. It then gives a history of past monitoring activities, and suggests training needed by Air Resource Specialists.



OPPORTUNITIES AND LEGAL  
RESPONSIBILITIES FOR PROTECTING  
NATIONAL FORESTS FROM AIR  
POLLUTION IMPACTS





## CHAPTER 2: OPPORTUNITIES AND LEGAL RESPONSIBILITIES FOR PROTECTING NATIONAL FORESTS FROM AIR POLLUTION IMPACTS

### INTRODUCTION

The purpose of this section is to describe how the Region can be involved effectively in protecting National Forest System (NFS) lands from air pollution, by taking advantage of the opportunities and responsibilities provided by various land management acts and the Clean Air Act.

The Clean Air Act of 1990, as amended, enables the Forest Service (FS) to protect air-quality-related values (any Wilderness components that can be modified by human-caused air pollution) in "Class I areas," which are Wildernesses in existence as of 8/7/77 and exceeding 5,000 acres, including later expansions. (All other NFS lands in the Rocky Mountain Region are Class II, including new Wildernesses.) This protection is available through implementation of the Act's Prevention of Significant Deterioration (PSD) provisions.

The 1964 Wilderness Act and regulations developed to implement it (36 CFR 293) identify overall management goals for Wilderness. Other land management acts related to managing Wilderness include the Organic Administrative Act of 1897, the Multiple-Use Sustained Yield Act (1960), the Forest and Rangeland Renewable Resources Planning Act (1974), and the National Forest Management Act (1976). State legislation and PSD regulations determine how the regulatory process is actually conducted in each state in the Region.

### THE FEDERAL CLEAN AIR ACT

The PSD sections of the Clean Air Act include a permit program for certain new sources of air pollution. The purposes of PSD include the protection and enhancement of air quality in national Wilderness areas and other locations of special scenic, recreational, historic, or natural value. Before the construction of certain new air pollution sources is approved, they must apply for and receive a PSD permit from the appropriate air regulatory agency. Within the Rocky Mountain Region, all states with Class I areas, except South Dakota, have been delegated the PSD permit program by the Environmental Protection Agency (EPA). In South Dakota, the EPA reviews new source permits.

Permit applicants must demonstrate that the proposed facility will (1) not violate national or state ambient-air-quality standards, (2) use Best Available Control Technology (BACT is the amount of air pollution control that a new source must install), (3) not violate either Class I or II increments for sulfur dioxide, nitrogen oxides, or particulates (see Table 2-1; "increments" are allowable pollutant concentrations that can be added to baseline concentrations), and (4) not cause or contribute to harmful effects on AQRV's (the general features or properties of an area [flora, fauna, soils, water, etc.] that have the potential to be changed by air pollution; see Table 2-2) in any Class I area.

Through the AQRV protection program, the Forest Service can safeguard Class I Wilderness, whereas Class II Wilderness and possibly other Class II NFS lands can be protected by the BACT program. The development of these analyses is very

technical, so that it can be quite costly for applicants develop their PSD permit applications.

Protection of Class I and II increments for total suspended particulates, sulfur dioxide, and nitrogen oxides is the responsibility of the states and the EPA. These values were not selected by Congress as concentrations needed to protect certain resources; they were basically "picked out of the air." It may therefore be possible to exceed the Class I increments without causing any human-caused change to a Class I Wilderness. Conversely, a Class I Wilderness could be affected without exceeding the increments.

In most cases it is not feasible to monitor Class I increments. For example, the annual increment for sulfur dioxide is so small that there are few, if any, air pollution monitors sensitive enough to detect such a minute concentration. therefore, increments are usually used only as a predictive tool and are estimated through modeling techniques.

The Forest Service, as federal land manager of 88 Class I Wilderness areas, is directly involved in the implementation of PSD. The Clean Air Act gives us "...an affirmative responsibility to protect the air quality related values (including visibility) of any such lands within a Class I area and to consider, in consultation with the Administrator, whether a proposed major emitting facility will have an adverse impact on such values." (The definition of "adverse impact" for an individual Wilderness depends on the specific components that will be protected, and to what degree. A "Wilderness component" is any individual constituent of the Wilderness, or group of them -- flora, fauna, etc.)

The Clean Air Act does not give the Forest Service responsibilities or direction for determining management goals for NFS Lands that differ from those found in the various land management acts. In fact, Section 310(a) of the Clean Air Act states that the Clean Air Act shall not be construed as superseding or limiting the authorities and responsibilities under any other provisions of law of any other Federal officer, department, or agency. In short, the Clean Air Act is only a tool available for meeting the management goals we must develop under the National Forest Management Act.

In other words, the Clean Air Act provides the legal and regulatory framework for protection of NFS Lands; it does not prescribe the management of them. Land managers must still decide what resources in Wilderness should be preserved, and to what extent. A protection program can then be formulated, based on management goals.

When a proposed facility will not violate any Class I increments, but the Forest Service can demonstrate to the satisfaction of the air regulatory agency that AQRV's in a Class I Wilderness will be degraded, the air regulatory agency must not issue the PSD permit. The determination to be made is whether the proposed facility will cause a change in a physical, chemical, biological, and/or social characteristic of a "sensitive receptor" within Wilderness, beyond an identified limit ("limit of acceptable change"). (A "sensitive receptor" is an element of an AQRV that is very sensitive to, or first modified by, human-caused air pollution. For example, *Xanthoparmelia cumberlandia*, a lichen species, is a sensitive receptor for flora.)

Three decisions must be made in this case:

1. What are the sensitive receptors within Wilderness that need protection?
2. What are the limits of acceptable change for these receptors?
3. Will the proposed facility result in pollutant concentrations or atmospheric deposition within Wilderness that will exceed the limits of acceptable change?

The first two decisions are land management issues which should be based on the management goals for the wilderness in question. The third is a technical question based on the modeled analysis of emissions from the proposed facility, meteorology, topography, chemical reactions in the atmosphere, and pollutant deposition or optical property within the wilderness.

All PSD permit applicants must evaluate the effect of their emissions on AQRV's. If the increments will not be exceeded, the FS has the burden of proof to demonstrate that an adverse effect will occur. If the increments will be exceeded, the permit can still be issued by the permitting agency, if the applicant can convince the FS that the emissions will not cause an adverse impact. Even when the proposed facility will cause a violation of a Class I increment, and the applicant cannot demonstrate to our satisfaction that the source will not adversely affect a Class I area, the permit can still be issued. In this case, the governor of the state where the facility is proposed for construction must recommend approval and transmit his recommendation to the President, who can approve or disapprove the application after reviewing the recommendations of the governor and Forest Service.

Close coordination between the FS and the appropriate air regulatory agency is required in PSD permitting. In nearly all cases, the air regulatory agency makes the final determination to grant or deny the permit. Under no conditions does the FS have this authority. We, however, are the party authorized to define "adverse impacts" on NFS Lands.

#### THE WILDERNESS ACT

The Wilderness Act of 1964 gives the FS the responsibility to manage designated Wildernesses to preserve and protect their unspoiled character. It defines Wilderness as "...an area where the earth and its community of life are untrammelled by man..." and "...an area of undeveloped Federal land retaining its primeval character and influence..." and "...is protected and managed so as to preserve its natural conditions..." "Untrammelled" means not subject to human controls or manipulations that hamper natural forces.

In addition to the Wilderness Act, the Code of Federal Regulations for managing Wilderness and primitive areas (36 CFR 293.2) states "...National Forest Wilderness resources shall be managed to promote, perpetuate, and where necessary, restore the wilderness character of the land..." Also, the National Forest Management Act gives us the authority to determine the management goals for Wilderness (which resources should be protected, and to what degree). These goals, along with the Wilderness Act, will help determine how "adverse impacts" should be defined for each Wilderness.

## WILDERNESS AIR RESOURCE MANAGEMENT PHILOSOPHY

The Wilderness Act and regulations developed to implement it do not directly address air quality, or air pollution effects on Wilderness. They do, however, direct us to determine what should be protected in Wilderness (the earth and its community of life) and how much (preserve natural conditions). Accordingly, the Region has developed the following premises related to air quality and Wilderness:

1. Wilderness is not merely a commodity for human use and consumption. Wilderness ecosystems have intrinsic values other than user/public concerns.
2. The objective of Wilderness management is to offer a natural user experience, rather than an enjoyable one. The amount of enjoyment is purely a personal matter for the individual user to decide.
3. All Wilderness components are equally important; none is of lesser value than another.
4. A Wilderness component is important even if users of the Wilderness are unaware of its existence.
5. All life forms are equally important. For example, microorganisms are as essential as elk or grizzly bears.
6. The goal of Wilderness management is to protect not only resources with immediate aesthetic appeal (i.e., sparkling clean streams) but also unseen ecological processes (such as natural biodiversity and gene pools).
7. The most sensitive Wilderness components are to be emphasized more than those of "average" or "normal" sensitivity. Sensitivity is generally determined by inertia (resistance to change), elasticity (how far the component can be stretched from its natural condition without being permanently modified), and resiliency (the number of times it can revert to its natural condition after experiencing human-caused change).
8. Each Wilderness component is important in itself, as well as in terms of how it interacts with other components of the ecosystem. That is, the individual parts of the Wilderness ecosystem are as significant as the sum of the parts.
9. The physical components of the ecosystem (for instance, lake chemistry) are as essential as its biological constituents (i.e., salamanders).
10. Wilderness components are to be protected from "human-caused change" rather than from "damage." Terms such as "damage" and "harm" are prejudicial, whereas "human-caused change" is value-neutral. (For example, deposits of nitrogen in a lake from nitrogen oxide, a common air pollutant, might result in more plant growth and bigger fish. This would, however, be an unnatural -- and therefore unacceptable -- change in the aquatic ecosystem).
11. The goal of Wilderness management is to protect natural conditions, rather

than the conditions when first monitored. That is, if initial monitoring in a Wilderness identifies human-caused changes, appropriate actions should be taken to remedy them, in order to restore natural conditions.

12. The designation of a Wilderness as Class I or II does not dictate the management goals for it; these are identified in the Wilderness Act. The designation only determines which options are available to meet the goals. Class I Wildernesses, for instance, can be protected through AQRV analysis, whereas the protection of Class II Wildernesses can be achieved using BACT requirements.
13. While it may not be possible to manage every Wilderness in a natural or near-natural state, each should be managed in as pristine a condition as the specific (local) biophysical, legal, scientific, and social/political situation will allow. That is, the Region will do the best job possible of Wilderness management, based on local constraints and opportunities. The extent of actual Wilderness protection, therefore, may vary.
14. Although monitoring is critical to any PSD decision, it must not interfere needlessly with Wilderness. For example, in mountain ranges or other geomorphic units of which only part is Wilderness, much of the most intrusive monitoring and instrumentation should be conducted in the adjacent non-Wilderness -- if such areas adequately represent the Wilderness of concern. Often, however, western Wilderness occupies an entire high-elevation area for which there is no truly representative non-Wilderness subjected to the same atmospheric deposition from a proposed source.

These premises will help the Region identify specific management goals for Wilderness and determine what should be monitored in order to identify human-caused changes.

#### OTHER LAND MANAGEMENT ACTS

Other land management acts related to managing Wilderness include the Organic Administrative Act of 1897, the Multiple-Use Sustained Yield Act of 1960, the Forest and Rangeland Renewable Resources Planning Act of 1974, and the National Forest Management Act of 1976. In summary, this legislation requires the FS to develop plans for multiple use of, and a sustained supply of goods and services from, the National Forest System, in a way that maximizes long-term net public benefit in an environmentally sound manner.

The Forest Service is required by law to develop specific management direction for all NFS lands, based on the general objectives identified in the Wilderness Act and subsequent regulations. Accordingly, Forest Plans are designed to articulate how individual Forests will be administered in order to achieve these objectives. Designated Wildernesses are managed in compliance with the Wilderness Act.

#### PROTECTING CLASS II WILDERNESS AND NON-WILDERNESS

Although the FS must comply with the Clean Air Act's minimum requirements (such as protection of Class I Wilderness), we are in no way prevented from doing more than the minimum. The Act offers many opportunities, as well as requirements, for us to protect other NFS lands from air pollution, including Class II Wilder-

ness and non-Wilderness. Because of the sensitivity of these areas' resources (such as outstanding visibility and lakes with extreme vulnerability to acidic deposition) and the potential air pollution threats to them, we have adopted the philosophy of using all available options to protect all lands within the Region from air pollution. Therefore, we may implement monitoring programs outside Class I Wildernesses and will continue to encourage states to develop legislation and regulations that will provide maximum protection for all NFS lands.

#### CONTROL OF POLLUTANTS FROM FOREST SERVICE LAND MANAGEMENT ACTIVITIES

The Clean Air Act requires the FS to comply with all federal, state, and local air quality regulations (Section 118). This obligates us to control air pollutants generated by our land management activities such as prescribed burning and operations on unpaved roads. In general, emissions from the latter have not been perceived as causing air quality concerns. Prescribed fire, however, is an intermittent source of particulates that can cause a significant short-term visibility problem. The State of Colorado requires a permit before such burning can be conducted; Wyoming requires us to model the emissions from each prescribed burn and demonstrate that they will not violate ambient particulate standards. Although South Dakota, Kansas, and Nebraska do not require permits for prescribed burning, no states allow these burns to violate ambient air quality standards.

#### THE PREVENTION-OF-SIGNIFICANT-DETERIORATION PERMIT PROCESS

The PSD permit process is complex. To be involved effectively, we must understand both how the regulations are written and how they are implemented.

Colorado and Wyoming have possibly the most effective PSD regulations in the country for enabling land managers to protect both Class I and Class II wildernesses. Both states have developed programs which allow for early and productive FS involvement in the permit process. Their PSD regulations are written and implemented differently, however.

**COLORADO PSD PERMITTING PROGRAM** - The Colorado PSD Regulations, like those of most states, are complex. The portions of Regulation No. 3, "A Regulation Requiring Air Contaminant Emission Notices, Emissions Permits, and Fees," that apply to Class I areas are summarized as follows:

Section VIII. Area Classifications - This section lists the eight Class I FS Wilderness areas, along with four Class I areas managed by the National Park Service. Colorado also allows for protection of Class I increments for sulfur dioxide in what have been termed "Colorado Category I Areas" in the Colorado Air Quality Control Act (1979). These include the Uncompahgre Mountain and Wilson Mountain Primitive Areas. It should be noted that both of these Primitive Areas no longer exist (portions of both were designated as Wilderness in 1980) except in the Colorado PSD regulations.

Section X. Air Quality Limitations - This section identifies the increments for Class I, Class II, and Class III areas (no areas in Colorado or any other state have been designated Class III). These are the same as the federal increments.

Section XIV. Federal Class I Areas - The provisions of this section make the Colorado PSD regulations the most effective in the nation for protecting Class I Wildernesses. They include:

**XIV. A.** - This subsection provides for FS involvement in the determination of permit completeness, which significantly adds to our ability to make effective recommendations on applications. The date when an application is determined to be complete is very important: After this determination is made, most states have only 30-90 days to complete their review and make a decision to grant or deny the permit. In most states, the Forest Service does not receive a PSD permit application until after the state has determined it to be complete and made a preliminary decision whether the permit should be granted. This causes three problems. First, we have only 30 to 60 days to complete a review and make a recommendation to the state. Such a short review period makes our job difficult or impossible. Second, most applications are not complete, when first received, in their assessment of effects on AQRV's. After the state determines the permit to be complete, however, it is usually impossible to get the applicant to supply more information or analysis. As a result, the FS does not have enough information in the application to determine what the impacts of the proposed source may be. Third, the state has already made its preliminary decision to grant or deny the permit, and it is usually difficult to change such a decision after it has been announced publicly.

In Colorado, both the state and the FS have 20 days to determine whether a permit application is complete. If it is, we have 30 days to submit an analysis of the acceptability of the proposed source, and the state has 60 days to issue or deny the application. In practice, the state usually requests and receives an extension of the 60-day review period. It may also require that the applicant provide additional information, if needed, during the 60-day review period.

Because the Forest Service can request that the state require the applicant to supply enough information in the PSD application for an adequate evaluation of effects on AQRV's to be conducted, we do not have the same problems with permit review in Colorado that occur in most other states.

**XIV. B.** - This subsection authorizes the state to require a source to conduct both pre- and post-construction monitoring of AQRV's in Class I areas; up to one year of pre-construction monitoring can be stipulated. Colorado is the only state in the country with such a requirement. Information from this monitoring can be used to determine the condition of AQRV's and the potential consequences of the proposed source. Though this may not be sufficient to conduct a complete analysis of impacts on AQRV's, it can be of significant assistance.

The specific provisions of this subsection are rather complex and should be reviewed in detail.

**XIV. C. Sources Impacting Federal Class I Areas - Additional Requirements** - This subsection authorizes the state to deny a PSD permit application even if the Class I increments are not exceeded, if the

Forest Service can convince the state that the source would cause an adverse impact in a Class I Wilderness area. This subsection also allows the state to make this determination if the FS fails to perform an adverse-impact analysis.

Program Implementation - In Colorado, the FS is usually invited by the State Air Quality Control Division to attend pre-application meetings with potential permit applicants. In these meetings, usually held a year or more before an applicant submits a permit application, the state informs the applicant what must be specifically addressed on the PSD permit application, and what air quality and AQRV monitoring must be conducted. The state usually requests (requires) that the FS furnish both the state and the applicant with the following:

1. A list of AQRV's that should be analyzed in the application, and the analysis techniques to be used.
2. The standards (limits of acceptable change) the FS will apply when reviewing the application.
3. The pre- and post-construction AQRV monitoring that should be conducted, and the monitoring techniques to be used.

Pre-application meetings are valuable because they involve the FS early in the permit process. This early involvement, however, often forces us to make a number of Wilderness-management decisions (concerning which components of the Wilderness should be protected, and how much) a year or more before an application is even received.

As required by the Federal Clean Air Act, Colorado requires that sources subject to PSD apply Best Available Control Technology (recall that BACT is the amount of air pollution control that a new source must install; it is determined by balancing the economic costs of control vs. the environmental consequences of the proposed facility). The State Air Quality Control Commission has indicated that it would give special consideration to analysis of impacts on AQRV's in Class II Wildernesses when determining BACT. Probably it could not deny a permit because of these impacts, but it could require more efficient control technology to mitigate or minimize them. Thus the Forest Service in Colorado can protect AQRV's in Class II Wildernesses to nearly the same degree as in Class I Wildernesses.

In summary, the Colorado PSD regulations are the most effective in the country in terms of opportunities for Wilderness protection. The FS can take advantage of these options, however, only if we are a pro-active participant in the permit process.

**WYOMING PSD PERMITTING PROGRAM** - The Wyoming PSD Regulations, like Colorado's, are complex. They do not, however, formally invite FS involvement in the determination of permit completeness, or in either pre- or post-construction monitoring of AQRV's, except for visibility. Only certain portions of the Wyoming Air Quality Standards and Regulations apply to Class I areas. These are summarized below.

Section 24. Prevention of Significant Deterioration - This section contains most of the requirements for permitting a new source, subject to the PSD regulations.

Section 24 (b) Table 1 - This table identifies the increments for Class I and Class II areas (Wyoming does not provide for reclassification of areas to Class III). The Wyoming and federal increments are the same.

Section 24 (b)(vi)(A) - This section says that the state may deny a PSD permit application, even if the Class I increments are not exceeded, if the FS can convince the state that the source would cause an adverse impact in a Class I Wilderness.

Section 24 (c) - This section categorizes all national Wildernesses in Wyoming as of January 25, 1979, as Class I areas (see Table 2). It should be noted that the Federal Clean Air Act identified all national Wildernesses in existence as of August 7, 1977, as Class I. As a result of the different dates, the Savage Run Wilderness, designated in 1978, is listed as a Wyoming Class I area, but is not so designated under the federal Clean Air Act.

Program Implementation - Wyoming implements the permit-completeness section of its PSD regulation differently than Colorado or any other state. The state will not consider an application to be complete until after the Forest Service is satisfied that the applicant has addressed all AQRV's. As a result, applicants find it in their best interests to work closely with us. Otherwise, we may not have enough information in the application to be able to make a recommendation to the state. If the state does not receive this from us, it will not consider the permit complete.

In Wyoming, we are also invited by the State to attend pre-application meetings with potential permit applicants. The State of Wyoming requests the same information from the FS at these meetings that Colorado does. The Air Quality Division in Wyoming has also said it would give consideration to FS analysis of effects on AQRV's in Class II Wildernesses when determining BACT.

The Wyoming Environmental Quality Act does not authorize the Wyoming Air Division to require permit applicants to conduct either pre- or post-construction monitoring of AQRV's, except for visibility. The state has, however, required applicants to conduct post-construction monitoring of atmospheric deposition within or adjacent to Wilderness. This monitoring has given extremely useful data to the FS.

#### FOREST SERVICE PSD PERMIT RECOMMENDATIONS

In order to protect Wildernesses from potential air pollution impacts, the Region must be able to make timely recommendations to state air regulatory agencies. States work with extremely short time frames in reviewing permit applications. Legally, they do not have the latitude to wait very long for us to develop and submit permit recommendations.

Furthermore, the recommendations we submit to the states must be very credible. If we developed and submitted a faulty PSD permit recommendation which was used

in the final permit decision, the state, rather than the FS, might be sued in court.

The Forest Service's PSD permit recommendations must also be effective. That is, we could make a timely permit recommendation that was scientifically accurate. If the State does not understand the legal mandates and philosophy behind what we are trying to protect, however, it would probably not consider our recommendation.

Finally, FS permit recommendations must be supported by the public. It is important, therefore, for us to coordinate with interest groups and inform the general public about air pollution and forest protection concerns.

As shown above, it is important for us to be pro-active in the PSD program and coordinate closely with the states. In nearly all cases, they make the final decisions on whether NFS lands will actually be protected from air pollution, so they should be involved in both developing and implementing all AQRV monitoring plans. Both Colorado and Wyoming have offered staff assistance in these activities.

#### PROGRAM ANALYSIS

To determine the effectiveness of the Regional air quality program, it should be evaluated from time to time. The following are some ways this may be accomplished:

1. **Implementation** monitoring could measure success in reviewing PSD permits, tracking Forest health, implementing Memorandums of Understanding (MOU's) with state air regulatory agencies, and properly executing prescribed-burn-ing plans.
2. **Effectiveness** monitoring could address the influence of FS recommendations on state decisions to issue PSD permits, progress in maintaining forest health, and the effectiveness of smoke-management techniques or training.
3. **Validation** monitoring could look at the appropriateness of models used in PSD permits; techniques for defining, measuring, and predicting improvements in Forest health; and techniques for reducing emissions.
4. **Trend** monitoring may consider whether air quality is improving or getting worse. It could also be used to complete periodic emission inventories or determine increment consumption, and relate these to trends in forest health and the attainment of our goal to reduce emissions and their adverse effects.

#### SUMMARY

The Forest Service has an outstanding opportunity to protect Wilderness within the Rocky Mountain Region from air pollution impacts. This is due, in part, to the PSD regulations of Colorado and Wyoming, which include significant FS involvement in the permit process. To take advantage of this, we must: (1) make management decisions on what resources should be protected from air pollution, and to what degree; (2) furnish high-quality information on the existing condi-

tion of AQRV's, atmospheric deposition, and air chemistry in Wilderness; and (3) understand the complexities of state PSD permit processes.

The air quality in our Wildernesses is both a vital natural resource in itself and a barometer of the overall atmospheric conditions throughout the National Forest System. By working with state air regulatory agencies and developing and implementing effective Wilderness air resource monitoring programs, we can help protect all NFS lands for present and future generations.

**TABLE 2-1**

**ALLOWABLE PSD INCREMENTS**

micrograms/meter<sup>3</sup> (ug/m<sup>3</sup>)

	Class I	Class II	Class III
<b>Sulfur Dioxide</b>			
Annual	2	20	40
24-Hour*	5	91	182
3-Hour*	25	512	700
<b>Total Suspended Particulates (TSP)</b>			
Annual	5	19	37
24-Hour*	10	37	75
<b>Nitrogen Oxides</b>			
Annual	2.5	25	50

\* - Not to be exceeded more than once a year.

SOURCE: 40 CFR 52.21 (c)

TABLE 2-2

**AIR-QUALITY-RELATED VALUES AND POTENTIAL AIR-POLLUTION-CAUSED CHANGES**

<i>Air-Quality-Related Value</i>	<i>Wilderness Characteristics Potentially Changed by Air Pollution</i>
1. Flora and Fauna	Rate of Growth, Mortality, and Reproduction; Direction of Succession; Amount of Visible Injury, Genetic Diversity, Productivity, & Abundance
2. Soil	Cation Exchange Capacity, Base Saturation, pH, Structure, Metals Concentration
3. Water	Total Alkalinity; pH; Concentration of Anions, Cations, Metals and Dissolved Oxygen
4. Visibility	Contrast, Visual Range, Coloration
5. Cultural-Archeological and Paleontological	Decomposition Rate
6. Odor	Odor

TABLE 2-3

**COLORADO WILDERNESS AREAS  
ADMINISTERED BY ROCKY MOUNTAIN REGION, FOREST SERVICE**

WILDERNESS AREAS - National Wilderness Preservation System Units administered under Code of Federal Regulations Title 36, Section 293.1 through 293.15

NAME OF AREA	NATIONAL FOREST	TOTAL ACRES	CLASS I ACRES	LAW AND DATE ESTABLISHED
Big Blue	Uncompahgre	98,584		P.L.96-560, 12-22-80
Cache La Poudre	Roosevelt	9,308		P.L.96-560, 12-22-80
Collegiate Peaks	Gunnison	49,094		P.L.96-560, 12-22-80
	San Isabel	83,231		
	White River	35,671		
Comanche Peaks	Roosevelt	66,901		P.L.96,560, 12-22-80
Eagles Nest	Arapaho	82,810	133,915	P.L.94-352, 07-12-76
	White River	51,105		
Flat Tops	Routt	38,870	38,870	P.L.94-146, 12-12-75
	White River	196,360	196,360	
Holy Cross	San Isabel	9,568		P.L.96-560, 12-22-80
	White River	113,842		
Hunter Frying Pan	White River	74,599		P.L.95-237, 02-24-78
Indian Peaks	Arapaho	40,180		P.L.95-450, 10-11-78
	Roosevelt	30,714		P.L.96-560, 12-22-80
La Garita	Gunnison	79,822	79,822	P.L.88-577, 09-03-64
	Rio Grande	24,164	24,164	P.L.96-560, 12-22-80
Lizard Head	San Juan	20,959		P.L.96-560, 12-22-80
	Uncompahgre	20,537		
Lost Creek	Pike	105,451		P.L.95-560, 12-22-80
Maroon Bells - Snowmass	Gunnison	20,364	20,364	P.L.88-577, 09-03-64
	White River	163,483	163,507	P.L.96-560, 12-22-80
Mount Evans	Arapaho	40,274		
	Pike	34,127		P.L.96-560, 12-22-80
Mount Massive	San Isabel	28,047		P.L.96-560, 12-22-80
Mount Sneffels	Uncompahgre	16,587		P.L.96-560, 12-22-80

Mount Zirkel	Routt	139,898	139,898	P.L.88-577, 09-03-64
Neota	Roosevelt	9,657		P.L.96-560, 12-22-80
	Routt	267		

**COLORADO WILDERNESS AREAS**  
**ADMINISTERED BY ROCKY MOUNTAIN REGION, FOREST SERVICE**

(Continued)

NAME OF AREA	NATIONAL FOREST	TOTAL ACRES	CLASS I ACRES	LAW AND DATE ESTABLISHED
Never Summer	Arapaho	7,441		P.L.96-560, 12-22-80
	Routt	6,659		
Platte River	Routt	743		P.L.98-550, 10-30-84
Raggeds	Gunnison	43,098		P.L.96-560, 12-22-80
	White River	16,832		
Rawah	Roosevelt	72,472	72,472	P.L.88-577, 09-03-64
	Routt	1,462	1,462	P.L.96-560, 12-22-80
South San Juans	Rio Grande	87,847		P.L.96-560, 12-22-80
	San Juan	39,843		
Weminuche	Rio Grande	164,767	164,767	P.L.93-632, 01-03-75
	San Juan	298,911	298,911	P.L.96-560, 12-22-80
West Elk	Gunnison	176,412	176,412	P.L.88-577, 09-03-64
				P.L.96-560, 12-22-80

TOTAL COLORADO WILDERNESS ADMINISTERED  
 BY ROCKY MOUNTAIN REGION, FOREST  
 SERVICE (R-2)

2,600,961    1,262,009

TABLE 2-4

**WYOMING WILDERNESS AREAS  
ADMINISTERED BY ROCKY MOUNTAIN REGION, FOREST SERVICE**

WILDERNESS AREAS - National Wilderness Preservation System Units administered under Code of Federal Regulations Title 36, Section 293.1 through 293.15

NAME OF AREA	NATIONAL FOREST	TOTAL ACRES	CLASS I ACRES	LAW AND DATE ESTABLISHED
Absaroka-Beartooth	Shoshone	23,283		P.L. 95-249, 3-27-78 P.L. 98-550, 10-30-84
Cloud Peak	Bighorn	189,039		P.L. 98-550, 10-30-84
Encampment River	Medicine Bow	10,124		P.L. 98-550, 10-30-84
Fitzpatrick	Shoshone	198,525	198,525	P.L. 94-557, 10-19-76 P.L. 98-550, 10-30-84
Huston Park	Medicine Bow	30,726		P.L. 98-550, 10-30-84
North Absaroka	Shoshone	350,488	350,488	P.L. 88-577, 9-3-64
Platte River	Medicine Bow	22,749		P.L. 98-550, 10-30-84
Popo Agie	Shoshone	101,870		P.L. 98-550, 10-30-84
Savage Run	Medicine Bow	14,930		P.L. 95-237, 2-24-78
Washakie	Shoshone	704,822	704,822	P.L. 92-476, 10-9-72 P.L. 98-550, 10-30-84

TOTAL WYOMING WILDERNESS ADMINISTERED  
BY ROCKY MOUNTAIN REGION, FOREST  
SERVICE (R-2) 1,646,556 1,253,835

TABLE 2-5

**SOUTH DAKOTA WILDERNESS AREA**  
**ADMINISTERED BY ROCKY MOUNTAIN REGION, FOREST SERVICE**

WILDERNESS AREAS - National Wilderness Preservation System Units administered under Code of Federal Regulations Title 36, Section 293.1 through 293.15

NAME OF AREA	NATIONAL FOREST	TOTAL ACRES	CLASS I ACRES	LAW AND DATE ESTABLISHED
Black Elk	Black Hills	9,826		P.L. 96-560, 12/22/80

TABLE 2-6

**NEBRASKA WILDERNESS AREA**  
**ADMINISTERED BY ROCKY MOUNTAIN REGION, FOREST SERVICE**

WILDERNESS AREAS - National Wilderness Preservation System Units administered under Code of Federal Regulations Title 36, Section 293.1 through 293.15

NAME OF AREA	NATIONAL FOREST	TOTAL ACRES	CLASS I ACRES	LAW AND DATE ESTABLISHED
Soldier Creek	Nebraska	7,794		P.L. 99-504, 10/22/86



# PRIORITY (RISK) ASSESSMENT





## CHAPTER THREE: PRIORITY (RISK) ASSESSMENT

### INTRODUCTION

#### THE BACKGROUND AND PURPOSE OF PRIORITY ASSESSMENT

Priority assessment is a strategic planning tool, using emissions and resource sensitivity information in 15 "airsheds" in Region 2 to assess the extent to which each airshed is at risk from air pollution. By evaluating the current status of monitoring, and identifying "holes" in the Region where monitoring is inadequate, this chapter helps set Regional priorities in air quality management and suggests how to allocate funding and staffing among the Forests and Regional Office. Also, it assists Forest ARM staffs in determining what emission sources are nearby, where coordination of monitoring efforts with adjacent Forests may be useful, and where and what type of monitoring can be initiated in the future.

The recommendations and priorities presented in this section are based on state-of-the-art knowledge as of 1991. This chapter will need to be revised as new information about emissions sources is gained and new monitoring efforts within the Region are initiated. The matrix combination process should be redone every 2-3 years using all the updated information available, and the current assessments are expected to become completely obsolete within five years.

#### AIRSHEDS

The priority assessment process was carried out for each of 15 different **airsheds** in Region 2. This approach serves two primary purposes: (1) to define areas of similar meteorological, topographical, and ecological conditions in which airflow patterns, pollutant concentrations, and sensitive receptors vary the least; and (2) to group emissions and resource sensitivities into conceptually manageable units so that these factors could be summarized easily and best utilized to aid management decisions. (Defining the Region's airsheds as all 68 Ranger Districts and National Grasslands would produce airsheds with too small a scale for the group to address; defining the two states of Colorado and Wyoming as airsheds would result in too large a scale to be meaningful.)

The airshed boundaries were drawn based on written input from approximately 30 people involved in Air Resource Management or meteorology in Region 2. The criteria to determine these boundaries emphasized topography and upper-level air flows, but also used political/civil boundaries (Forests, Wilderness Areas, counties) where physical boundaries were not apparent. Airshed maps for Region 2 are shown in Appendix 1. **Pollution emissions sources** were considered in this priority assessment for each airshed (Appendix 2). Both existing and potential sources are included in the emissions source list. The impact of each pollution source has been estimated by looking at the amount and type of emissions, and the proximity of the source to National Forest lands.

#### THE MATRIX COMBINATION PROCESS

The matrix combination process is useful because it can incorporate value judgments (expressed as "Degree of Concern") about the potential threat from an emissions source to a sensitive resource, in a relatively objective and consis-

tent manner. This was important in the process because in many cases there were large unknowns in some of the matrix elements that could not be quantified (for example, what are the chances that a power plant will be built near Cloud Peak Wilderness? How susceptible to air pollution are the terrestrial plants in the Indian Peaks Wilderness?). Matrix combination is a tool to evaluate current and potential impacts on sensitive receptors, in the absence of specific numerical information for most of the sensitive receptors in most of the airsheds.

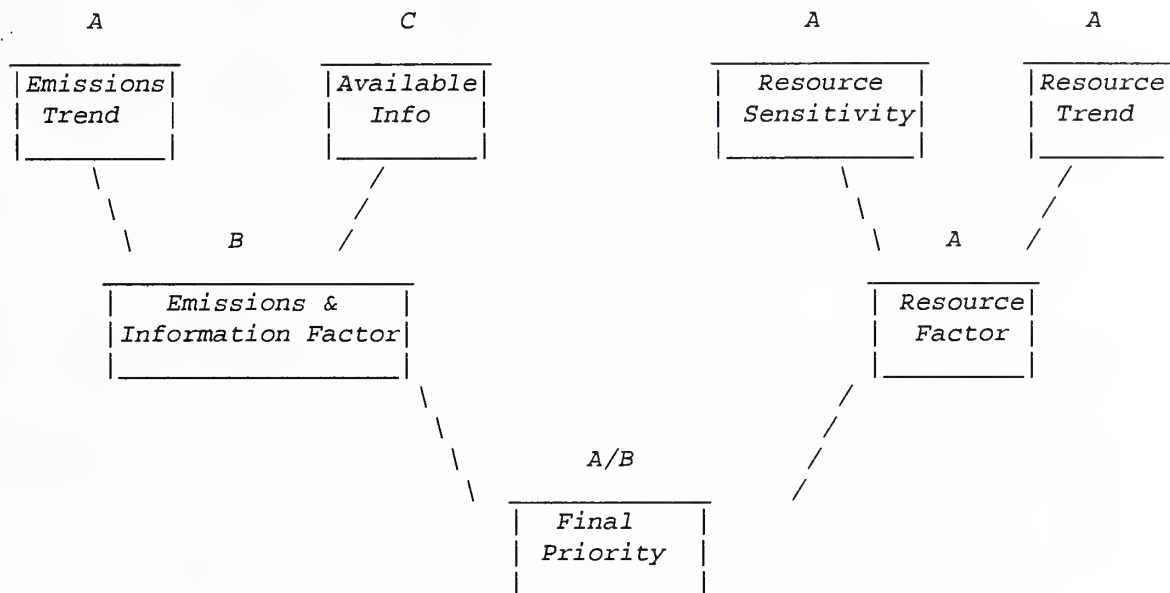
Four measures of risk ("Resource Sensitivity," "Resource Trend," "Emissions Trend," and "Available Information") were integrated for **visibility**, **aquatic resources**, **terrestrial resources**, and **supporting information** for each emissions source in each airshed, using matrix combination. The factors were combined in a series of matrix tables, (for an example, see Table 3-1). All known information for each risk was discussed by the group and given a priority rating of "A," "B," "C," or "D." "A" indicated a high level of concern or risk inherent in the factor; "D" represented a low level of concern. These ratings were combined in the matrix-table format to result in a final, relatively objective ranking for the threat to visibility, aquatic resources, and terrestrial resources, or the need for supporting information, from each major emissions source in each airshed.

**Resource sensitivity** was the category used to establish what was most likely to be at risk from air pollution impacts in the airshed, and considered changes in aquatic, terrestrial, visibility, and deposition information. When little was known about the sensitive receptors in an area, the working group made its best effort to characterize the resource. **Resource trend** included existing, established, or projected trends in resource sensitivity to air pollution or acidic deposition in each airshed. Trend forecasts were based on emission patterns or other factors affecting aquatic, terrestrial, or visibility resources, such as their responses to increasing human use, population dynamics, etc. **Available information** assessed whether we had any baseline data, what models and analysis tools were available, whether there were information gaps, and, if so, whether we were lacking information over time or space. The **emissions trend** category examined projected trends from existing pollution sources (increasing, decreasing, or no change) and the likelihood of proposed sources being built (likely, doubtful, or unknown). Tables 3-2 and 3-3 detail how each of these factors are combined to produce initial rankings (see table 3-1 for an overview of the entire matrix process).

Table 3-1

**AN EXAMPLE OF THE MATRIX COMBINATION PROCESS**

Suppose a new power plant is to be built. The priority for monitoring aquatic resources in response to the power plant would be determined as follows:



The matrix combination process assigns a value of A, B, C, or D to the information in each box. An "A" represents the highest level of concern and "D" the lowest. Values from each level are combined to form the value of the box below. If the power plant is expected to cause increased emissions, the "Emissions Trend" level of concern might be "A." For aquatic resources, the amount of "Available Information" is judged to be good, resulting in a "C" level of concern. This combination results in an "Emissions and Information Factor" of "B."

Going back to the top row of boxes, the "Resource Sensitivity" is very high (lots of sensitive lakes in the area) and therefore earns an "A" rating. The "Resource Trend" may be expected to change if the new power plant results in additional acidic deposition, so the level of concern is "A". The combination of these two factors results in a "Resource Factor" of "A". Combining the ratings for the two factors in the middle row, the final priority for monitoring aquatic resources in response to the power plant risk is "A/B". This process is repeated for "Terrestrial", "Visibility", and "Supporting Information" for each emissions source (or group of like sources) in each airshed.

Table 3-2

HOW EMISSIONS TREND AND AVAILABLE INFO ARE COMBINED

Available Information

		No Info And Need It	Some Info And Need More	Getting O.K. Baseline Now	No Info But Don't Need It
E M I S S I O N S	Existing Source With No Emissions Change Or Decreasing Emissions	B	B/C	C	D
S I O N S	Existing Source With Increasing Emissions	A	B	B/C	D
T R E N D	Proposed Source With Development Assured	A	A	B	D
	Proposed Source With Development Possible	A	B	C	D
	Proposed Source With Development Long-shot	B	C	D	D

Table 3-3

HOW RESOURCE TREND AND RESOURCE SENSITIVITY ARE COMBINED

Resource Trend

		Major Change Apparent Or Expected	Some Change Apparent Or Expected	Little/No Change Apparent Or Expected	Degree Of Change Is Unknown
R S E E S N O S U I R T C I E V	Very Sensitive	A	A	B	A
	Moderately Sensitivity	A	B	C	B
I T Y	Unknown Sensitivity Or Poor Indicator Of Change	?	B	D	C

After matrix combination is complete, the final priority ranking indicates the following:

- "A" = A top priority for monitoring, because of high threat to a sensitive resource. We have little or no information on the resource, and we need more, to be able to protect it.
- "B" = A slightly less perceived threat to a resource than in category A, based either on sensitivity or emissions. Monitoring whenever possible is recommended.
- "C" = Monitoring is not viewed as a high priority, based on available information. The threat to the resource is seen as limited, because of low projected emissions, the resource is a poor indicator of change, or sufficient data are already available.
- "D" = Monitoring is optional. It may become relevant to monitor a "D" priority under several circumstances, such as a change in political priorities, special funding opportunities, or new information on the sensitivity of the resource or projected emissions.

These assessments were based on the consensus of the work-group participants, representing the best available knowledge, judgement, and experience with AQRV's; current, proposed, or projected emission sources; meteorological information; and local conditions. Included were nine Air Resource Management representatives, from the R2 Regional Office, Forests, Districts, and the Colorado Department of Health, Air Quality Division. Input was also received by phone from the Wyoming Air Quality Division. (Originals of the group worksheets and ratings notes for each emission source in each airshed are available at the Region 2 Regional Office.)

#### ASSUMPTIONS

Some generalizations and assumptions the group used regarding resource sensitivity were: (1) lakes with low alkalinity are very sensitive, (2) good and very good visibility is a very sensitive resource, and (3) aquatic resources are generally better indicators of change than terrestrial ones. Assumptions about emission trends were: (1) the emission-trend category of "existing with no change" also included situations in which decreasing emissions trends were predicted, and (2) smoke emissions from prescribed burning or wildfire were considered to be intermittent impacts, and were not included in this priority assessment.

When information about a category was unknown, we made our best guess about how to rank the information, always trying to err on the side of conservatism (i.e., giving the highest degree of resource protection). Assumptions about the matrix combination process itself were that (1) the matrices were used to combine non-numerical information without assigning numerical values, weighting, or ranking, and (2) this assessment is not a cause-and-effect or projected-harm assessment.

## RESULTS OF THE PRIORITY-ASSESSMENT PROCESS: REGION 2 AIRSHED SUMMARIES

The airshed summaries below are general descriptions, outlining the current state of knowledge about risks, resource sensitivities, and any other general information gained from the priority-assessment process for each airshed. A summary of the priority rankings is also included by airshed. More information on how the rankings were arrived at can be obtained from the original ratings sheets, archived in the Regional Office.

### **BIGHORN AIRSHED**

This contains the western portions of the Bighorn National Forest and the Cloud Peak Wilderness. The airshed is affected by oil and gas development in the Bighorn basin. Prevailing winds are westerly or southeasterly, with occasional northerly and easterly flows. With this airflow pattern, the west slope of the Cloud Peak Wilderness is more susceptible to impacts from sources in the Bighorn Basin. No additional sources are anticipated. NO<sub>x</sub> is the primary pollutant of concern. Visibility and lichens have been identified as potentially sensitive to pollutant effects. We do not know of any monitoring currently occurring in this airshed.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
A	visibility	none	oil & gas + other NO <sub>x</sub> sources
A	terrestrial	none	oil & gas + other NO <sub>x</sub> sources
A	support.info	none	oil & gas + other NO <sub>x</sub> sources
C/D	aquatics	none	oil & gas + other NO <sub>x</sub> sources

### **CANON CITY AIRSHED**

The portions of the Rio Grande and the Pike & San Isabel NF's east of the Continental Divide and southwest of the mountainous area usually referred to as the Front Range are contained in this airshed. Wilderness Areas in the airshed include eastern sections of the South San Juan, Weminuche, La Garita, Collegiate Peaks, Holy Cross, and Mt. Massive. The airshed is affected by urban-area emissions within it, and probably regional haze from the Southwest (Arizona, New Mexico, and Southern California). Agricultural burning and area sources from Alamosa are relatively minor contributors to air quality problems. Potential emissions include a cement plant outside Canon City that has been proposed to burn hazardous waste. Little is known about sensitive receptors in this airshed.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
A	visibility	some	oil & gas development (CO & NM)
A	visibility	some	regional emissions from S.W. U.S.
B	aquatics	none	regional emissions from S.W. U.S.
B	aquatics	none	oil & gas development (CO & NM)
C	aquatics	none	Canon City & Alamosa industry
D	visibility	none	Canon City & Alamosa industry

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
D	terrestrial	none	Canon City & Alamosa industry
D	terrestrial	none	oil & gas development (CO & NM)
D	terrestrial	none	regional emissions from S.W. U.S.

#### FOUR CORNERS AIRSHED

This includes the San Juan NF and portions of the Uncompahgre and Gunnison NF's, as well as the Lizard Head, Mt. Sneffels, and Big Blue Wildernesses and western portions of the La Garita, Weminuche, and South San Juan Wildernesses. The Four Corners airshed is affected by oil and gas development, primarily coal-bed methane emissions coming from southwest Colorado, northwest New Mexico, southeastern Utah, and northeast Arizona. It is also affected by power plant operations in New Mexico and emissions from diffuse or distant sources to the southwest.

Proposed or potential emissions sources include additional power plants and continuing oil and gas development. NO<sub>x</sub> and acid deposition are the principal pollutants of concern. Visibility<sup>x</sup> and lakes with low alkalinity (little to no buffering capacity) have been identified as sensitive resources. Lake chemistry, visibility, and precipitation chemistry are currently being monitored in the Weminuche Wilderness. Terrestrial and cultural resources may also be sensitive to pollution effects; however, little information is available about their current status or possible response to changing air quality in this airshed.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
A	aquatics	some	N.M. power plant (proposed)
A	aquatics	some	SW U.S. regional emissions
A/B	visibility	some	SW U.S. regional emissions
A/B	aquatics	some	San Juan & 4-Corners power plants
A/B	terrestrial	none	SW U.S. regional emissions
B	visibility	some	San Juan & 4-Corners power plants
B	visibility	some	oil & gas development
C	supp. info	some	San Juan & 4-Corners power plants
C	visibility	some	N.M. power plant (proposed)
C	aquatics	some	oil & gas development
C	supp. info	yes	oil & gas development

#### FRONT RANGE AIRSHED

This contains parts of the Pike, Arapaho, and Roosevelt NF's. It includes the Lost Creek, Neota, Mt. Evans, Commanche Peaks, and Cache La Poudre Wildernesses, and the eastern portion of the Indian Peaks Wilderness. Mobile and area sources in the Fort Collins/Denver/Colorado Springs corridor produce pollutants that may impact NF lands, including SO<sub>2</sub>, NO<sub>x</sub>, particulate matter, and ozone. Eleven large power plants are in this corridor, and four more are proposed.

Another pollution source potentially impacting National Forests in the Front Range is oil and gas development. Some visibility data have been collected in this airshed, but most of the sites are at lower elevations than NF lands. Little information is available on sensitive receptors on NF lands here, yet they are at relatively high risk, because of the great number of sources along the Front Range corridor and the high potential for more prospective sources to go through the PSD permitting process.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
A/B	visibility	some	Denver Metro area sources
A	visibility	none	Colo. Springs & Pueblo sources
A/B	aquatics	some	Denver Metro area sources
A/B	terrestrial	none	Denver Metro area sources
B	aquatics	none	Colo. Springs & Pueblo sources
B/C	terrestrial	some	Colo. Springs & Pueblo sources
B/C	support. info	yes	Denver Metro area sources
B	support. info	some	Colo. Springs & Pueblo sources

#### GRANBY AIRSHED

The Granby Airshed contains portions of the Arapahoe (west of the Continental Divide), the White River, and the Routt NF's. The Eagles Nest Wilderness, the western part of the Indian Peaks Wilderness, and the northern portion of the Collegiate Peaks Wilderness are also included. This airshed is affected by regional haze from the Southwest, local haze (from a teepee burner in Walden and the AMAX, Climax, and Henderson mines), and ski-area-related development (fireplace and vehicle sources, producing mostly particulate matter). There are no proposed sources requesting permits in this airshed. Little information is available on its sensitive resources, but visibility is probably very sensitive. Synoptic sampling in progress indicated there are several very sensitive lakes here. A limited amount of monitoring has been done in this area, with more planned.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
A	visibility	none	Summit County ski areas
C	aquatics	some	regional emissions SW U.S.
C	terrestrial	some	regional emissions SW U.S.
D	visibility	none	regional emissions SW U.S.
D	aquatics	some	Summit County ski areas
D	terrestrial	some	Summit County ski areas

#### GRAND JUNCTION AIRSHED

This includes portions of the White River and Grand Mesa NF's, as well as the northern part of the Maroon Bells-Snowmass, northern Collegiate Peaks, western Holy Cross, and all of the Hunter-Fryingpan and Flat Tops Wildernesses. It is affected by emissions from the Grand Junction urban/industrial area, including

the Cameo power plant, the waferboard plant in Olathe, Western Slope Refining in Fruita, agricultural burning, and the urban area itself. It is also affected by oil and gas development in the western portion of the airshed, and regional emissions from the Aspen-Glenwood corridor.

Potential emission sources that may be developed in this area in the next few years include a co-generation plant in the Glenwood area, a waste-coal power plant near Carbondale, and oil-shale processing. SO<sub>x</sub>, NO<sub>x</sub>, and acidic deposition are the pollutants of concern. Most of the AQRV monitoring in this airshed has been done in the Flat Tops Wilderness (lake chemistry, atmospheric deposition, and lichen monitoring); visibility and lakes monitoring have recently begun in the Maroon Bells wilderness.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
A	visibility	some	Carbondale waste coal plant (prop.)
A	visibility	none	Grand Jct. metro/industrial area
A	visibility	none	Western slope refining (Gary refining)
A	visibility	none	UNOCAL & CB oil shale
A	visibility	some	Regional emissions from S.W. U.S.
A	aquatics	none	West Slope Refining
A	aquatics	yes	Regional emissions from S.W. U.S.
A	terr. (lichens)	some	Regional emissions from S.W. U.S.
A/B	visibility	some	Glenwood/Aspen area emissions
B	visibility	none	Agricultural burning
B	visibility	some	Cameo power plant
B	visibility	some	Olathe waferboard
B	visibility	some	Glenwood Area Co-gen. Plant (prop.)
B	aquatics	yes	UNOCAL & CB oil shale
B	aquatics	some	Cameo power plant
B	terrestrial	some	UNOCAL & CB oil shale
B	terrestrial	none	Cameo power plant
C	aquatics	some	Carbondale waste-coal plant (prop.)
C	terrestrial	none	Carbondale waste-coal plant (prop.)
D	aquatics	none	Grand Jct metro/industrial area
D	terrestrial	none	Grand Jct metro/industrial area

#### **GREATER YELLOWSTONE AIRSHED**

The Shoshone NF in R-2 and the Bridger-Teton NF and a portion of the Targhee NF in R-4 are in this airshed. It also includes the Popo Agie, Fitzpatrick, Washakie, and North Absaroka Wildernesses in R-4, and part of the Absaroka-Bear-tooth Wilderness in R-2. In R-4, it also includes the Bridger, Gros Ventre, Teton, and Jedediah Smith Wildernesses, and a portion of the Winegar Hole Wilderness.

Although this airshed does include NF lands in R4, the following summary and strategy are focused only on lands in R2. Coordination, consultation, and cooperation between adjacent Forests and Regions will continue.

The Greater Yellowstone airshed is affected by oil and gas development in the Riley Ridge/Big Piney/LaBarge area, and by regional emissions from the southwest. Potential emission sources include a gold mine proposed by Noranda and a treatment plant for natural gas.  $SO_x$ ,  $NO_x$ , acid deposition,  $H_2S$ , and trace metals are the pollutants of concern. Visibility, lichens, and lakes with low alkalinity been identified as sensitive to pollutant effects. Lake chemistry, visibility, and precipitation chemistry are being monitored in or near the Bridger, Fitzpatrick, and Popo Agie Wildernesses. One lichen inventory of limited scope has been done, and lake sediments and glacial cores have been analyzed from some of the these three Wildernesses.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
A	visibility	some	oil & gas (Big Piney, LaBarge, Riley)
A	visibility	none	Noranda gold mine (proposed)
A	aquatics	yes	oil & gas (Big Piney, LaBarge, Riley)
A	terrestrial	some	oil & gas (Big Piney, LaBarge, Riley)
A	terr.(lichens)	some	regional haze (CO, UT, WY)
A	support.info	some	oil & gas (Big Piney, LaBarge, Riley)
A/B	support.info	some	Noranda gold mine (proposed)
B	visibility	some	regional haze (CO, UT, WY)
B/C	aquatics	yes	regional haze (CO, UT, WY)
B/C	terrestrial	none	Noranda gold mine (proposed)
C	aquatics	some	Noranda gold mine (proposed)

#### GUNNISON AIRSHED

The Gunnison NF and a small portion of the Grand Mesa NF are in this airshed. Also included are the West Elk and Raggeds Wildernesses, along with the southern portion of the Maroon Bells-Snowmass and the western part of the Collegiate Peaks Wildernesses. The airshed is affected by regional haze from the southwest (Colorado, New Mexico, Arizona, Southern California), plus sources in the Grand Junction area. Emissions from these sources are expected to increase over the next 10-20 years, based on population development and projected new power plants. Under this scenario,  $NO_x$ ,  $SO_2$ , and particulates can be expected to increase. Information on sensitive resources in this airshed is lacking, but synoptic sampling of lakes to determine sensitivity to acidic deposition has recently begun, and there is some evidence to suggest its salamander populations may be very sensitive to acidic deposition.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
A	visibility	some	regional emissions (SW USA + Grand Junction)
A	aquatics	some	regional emissions (SW USA + Grand Junction)

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
A	terrestrial	some	regional emissions (SW USA + Grand Junction)
B/C	support.info	yes	regional emissions (SW USA + Grand Junction)

#### LA JUNTA AIRSHED

This contains the Comanche National Grassland in southeastern Colorado and the Cimarron National Grassland in southwest Kansas. The airshed is affected by several small power plants near Lamar and by agricultural burning. No additional sources are expected in the near future. There is little information available about pollutant effects on grasslands' natural and cultural resources.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
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Not enough known on resources or sources to assign priorities.

#### LA SAL AIRSHED

This consists of a portion of the Uncompahgre National Forest encompassing the Uncompahgre Plateau. The airshed is affected by the Nucla power plant, a relatively "clean" source. The power plant may contribute some emissions to the regional haze affecting the Grand Junction, Four Corners, and Gunnison airsheds. There is no information about visibility or possibly impacted aquatic or terrestrial resources in this airshed.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
C	visibility	none	Nucla power plant
D	aquatics	none	Nucla power plant
D	terrestrial	none	Nucla power plant

#### MEDICINE BOW AIRSHED

This airshed covers parts of both Colorado and Wyoming, and includes the Medicine Bow and Routt NF's and a portion of the Roosevelt NF. It encompasses the Snowy Range Scenic Byway and the Mt Zirkel, Encampment River, Huston Park, Platte River, Savage Run, and Rawah Wildernesses. The airshed also includes the Glacier Lakes Ecosystem Experiment Site (GLEES), a long-term research site operated by the Rocky Mountain Experiment Station.

This airshed is affected by oil and gas development downwind, including the Meeker-Rangely area, the Craig and Hayden power plants, and local ski-area development. Dust from mineral development may also be a factor, in addition to some regional emissions. Concern has also been expressed about smoke from

forest and agricultural burning, and about emissions from the tee-pee burners in Encampment and Saratoga, Wyoming.

Oil-shale processing and oil and gas development are the most likely future sources to be proposed for development. The primary pollutants of concern are  $SO_2$ ,  $NO_x$ , and particulate matter. This airshed contains lakes sensitive to acidic deposition (monitored in the Mt Zirkel Wilderness and at GLEES on the Medicine Bow NF). Visibility is also a very sensitive resource here, and is being monitored by camera at GLEES and in the Mt Zirkel Wilderness. GLEES also monitors meteorology, ozone, deposition, particulates, snow and stream chemistry, and vegetation. Sensitive resources may exist in other areas of this extensive airshed, but have not yet been monitored.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
A	visibility	some	Meeker/Rangely oil & gas development
A	visibility	some	Craig and Hayden power plants
A	visibility	some	Steamboat area sources
A	visibility	some	Unocal & CB oil shale facility
A	aquatics	yes	Craig and Hayden power plants
A	terr. (lichens)	some	Meeker/Rangely oil & gas development
A	support. info	some	Craig and Hayden power plants
A/ B	visibility	some	regional emissions (UT, WY, CO)
A/B	aquatics	some	regional emissions (UT, WY, CO)
A/B	terrestrial	some	Craig and Hayden power plants
B	aquatics	some	Meeker/Rangely oil & gas development
B	terrestrial	some	regional emissions (UT, WY, CO)
C	aquatics	some	Moon Lake power plant - Utah
C	terrestrial	none	Meeker/Rangely oil & gas development
C	visibility	some	Moon Lake power plant - Utah

#### PLAINS AIRSHED

This vast airshed includes the Samuel R. McKelvie NF, the Bessey Ranger District of the Nebraska NF, the Black Elk Wilderness, the Ft. Pierre NG, and the eastern half of the Buffalo Gap NG. It encompasses all of South Dakota and Nebraska except the western areas in these states which are in the Thunder Basin, Wheatland, and Front Range airsheds.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
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Not enough known on resources or sources to assign priorities.

## RED DESERT AIRSHED

This large area in Wyoming extends from the southwest corner of the state almost to Casper. No National Forests are within this airshed; much of the land is state, private, or BLM. Pollution sources are the Salt Lake City urban area and localized mineral and energy development in Utah and southwest Wyoming (Green River). Sources of  $SO_2$  or  $NO_2$  emitting more than 100 tons per year exist within the airshed.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
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No National Forest Lands exist within this airshed, so no threat assigned.

## THUNDER BASIN AIRSHED

This airshed includes the east portion of the Bighorn NF, a portion of the Black Hills NF, and the Thunder Basin National Grassland. It has the eastern portion of the Cloud Peak and all of the Black Elk Wilderness. The airshed is affected by oil and gas development in the Billings area: pollutants from the area are carried into the airshed by northwesterly winds. It is also affected by Powder River Basin coal field developments and oil- and gas-related emissions.

We have no knowledge of any proposed emission sources in the South Dakota portion of this airshed. In Wyoming, oil and gas development is a current source, and a major coal-fired power plant is proposed near Lake DeSmet, potentially impacting the nearby Cloud Peak Wilderness when easterly winds occur. There is very little AQRV information available about this Wilderness to use in the PSD permit process.  $NO_x$ ,  $SO_x$ , and particulate matter are the principal pollutants of concern.  $High-x$  elevation lakes are suspected to be a sensitive resource; however, there is little information about their current status or possible response to changing air quality. Visibility and terrestrial resources are also potentially sensitive resources. There is some visibility information available, but there is no ongoing systematic monitoring. Some particulate monitoring information is available within the Thunder Basin National Grassland, and limited particulate  $SO_2$ , ozone, and  $NO_x$  data are available from monitoring stations operated by the oil and gas<sup>x</sup> and coal-mining companies.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
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A	visibility	some	Lake DeSmet power plant (proposed)
A	aquatics	some	Billings oil and gas development
A	aquatics	some	Lake DeSmet power plant (proposed)
A	terr. (lichens)	none	Lake DeSmet power plant (proposed)
A	supp. info	some	Billings oil and gas development
A	supp. info	some	Lake DeSmet power plant (proposed)
B/C	visibility	some	Billings oils and gas development
C	terrestrial	none	Billings oil and gas development
C	terr. (amphibs)	none	Lake DeSmet power plant (proposed)
D	visibility	none	Powder River coal fields

## **WHEATLAND AIRSHED**

This airshed includes the Nebraska NF, portions of the Black Hills NF, and the Ogalala National Grassland. It also contains the Soldier Creek Wilderness. The airshed is affected by the Wheatland power plant, a source of SO<sub>2</sub> and NO<sub>x</sub>. The power plant stacks have wet and dry scrubbers which reduce<sup>2</sup> emissions. SO<sub>2</sub> and NO<sub>x</sub> sampling was conducted in the vicinity of the power plant for several<sup>x</sup> years. No additional sources are expected soon within the airshed. Airborne dust and agriculture- or forestry-related burning may occasionally contribute to visibility impairment within the airshed. There is little information available about pollutant effects on grasslands or lower-elevation pine forests, and no monitoring of air-quality-related values has been conducted in the airshed, to our knowledge.

Priority Rank	Type of Monitoring	Adequate Monitoring?	Potential Threat
D	Visibility	none	Wheatland power plant

## **PRIORITY ASSESSMENT SUMMARY**

### **FOREST USES FOR PRIORITY ASSESSMENT**

The information in this priority assessment and Appendices 1 and 2 can be used by Forests as a stepping-off point for their Air Resource Monitoring plans. The general information on airflows, pollution-source threats, and sensitive resources can be expanded for local conditions near each Wilderness or other area of concern. Forest Air Resource Coordinators may also use the information to help determine their monitoring priorities and where to begin a new air resource monitoring program.

In addition, the assessment can be used to determine where coordination efforts can be initiated to monitor on an airshed basis, and save duplication between neighboring Forests. Forest Supervisors or staffs may wish to review the airshed summaries to get a quick, general idea about air quality issues, threats, and sensitive resources for the airshed(s) in which their Forest is located. Finally, the assessment will help Forest Air Resource Coordinators learn which emission sources nearby are threats and which sensitive resources may be at risk on their Forest.

### **REGIONAL OFFICE USES FOR PRIORITY ASSESSMENT**

The Regional Office can use the assessment to help plan how best to distribute funds in the Region, by establishing where the problems, priorities, and risks are greatest between and within airsheds, and where new monitoring programs need to be initiated. The priority assessment will also help the RO determine where to help Forests coordinate monitoring, to protect resources most effectively in each airshed.

## MONITORING RECOMMENDATIONS

One of the main objectives of this assessment was to establish where there are "holes" in the Regional monitoring network. These are generally areas where "A" priorities have been identified, but little or no monitoring has been initiated. In addition to the new monitoring recommended below, it is a high priority in the Region to continue any long-term monitoring programs that have already been initiated in areas of "A" and "B" concern.

Areas where the assessment indicates new monitoring should be initiated include:

1. Visibility, aquatics, and lichen monitoring in the **Thunder Basin Airshed** (east side of the Cloud Peaks Wilderness), to obtain baseline data to address impacts from the proposed Lake De Smet power plant.
2. Visibility, terrestrial, and supporting information in the **Bighorn Airshed** (west side of the Cloud Peaks Wilderness), to determine the effects of oil and gas development or other sources of  $\text{NO}_x$ .
3. Visibility impacts from oil and gas development and from a proposed gold mine in the **Greater Yellowstone Airshed**. In addition, the terrestrial consequences of oil and gas development and regional haze have not been adequately addressed in the past in this airshed.
4. Visibility information in the **Grand Junction Airshed** is lacking to determine effects on the Flat Tops Wilderness from the Grand Junction metro area, potential oil-shale development, and Western Slope Refining (formerly Gary Refining).
5. Visibility information for the **Front Range Airshed** is needed to assess the consequences of Colorado Springs/Pueblo sources for Front Range Wilderness Areas.
6. Visibility effects are a major concern in the **Medicine Bow Airshed**. Monitoring by a visibility camera has recently begun on the Routt NF near Steamboat Springs, and on the Medicine Bow NF, but particulate monitoring also needs to be initiated at these locations.
7. Visibility impacts in the **Granby Airshed** are a concern, but are not being monitored.

Visibility monitoring is and should continue to be emphasized throughout the Region, for the following reasons: It is an easily observable (by the public) impact on National Forest lands; it can be tracked using established monitoring techniques; it is specifically recognized in the Clean Air Act as an air-quality-related value that needs to be protected; established models exist that can estimate for the PSD permitting process how a new source may impact visibility in Forest Service Wilderness; and Region 2 has some of the best visibility in the country, and the Forest Service should do all in its power to see that it is maintained or even improved.

This assessment has underlined our ignorance about air pollution impacts on grasslands: we lack information on these ecosystems' sensitive resources.

Fortunately, grasslands are currently at less risk than other areas of the Region, because of fewer pollution sources and better dispersion in the Region's eastern portion.

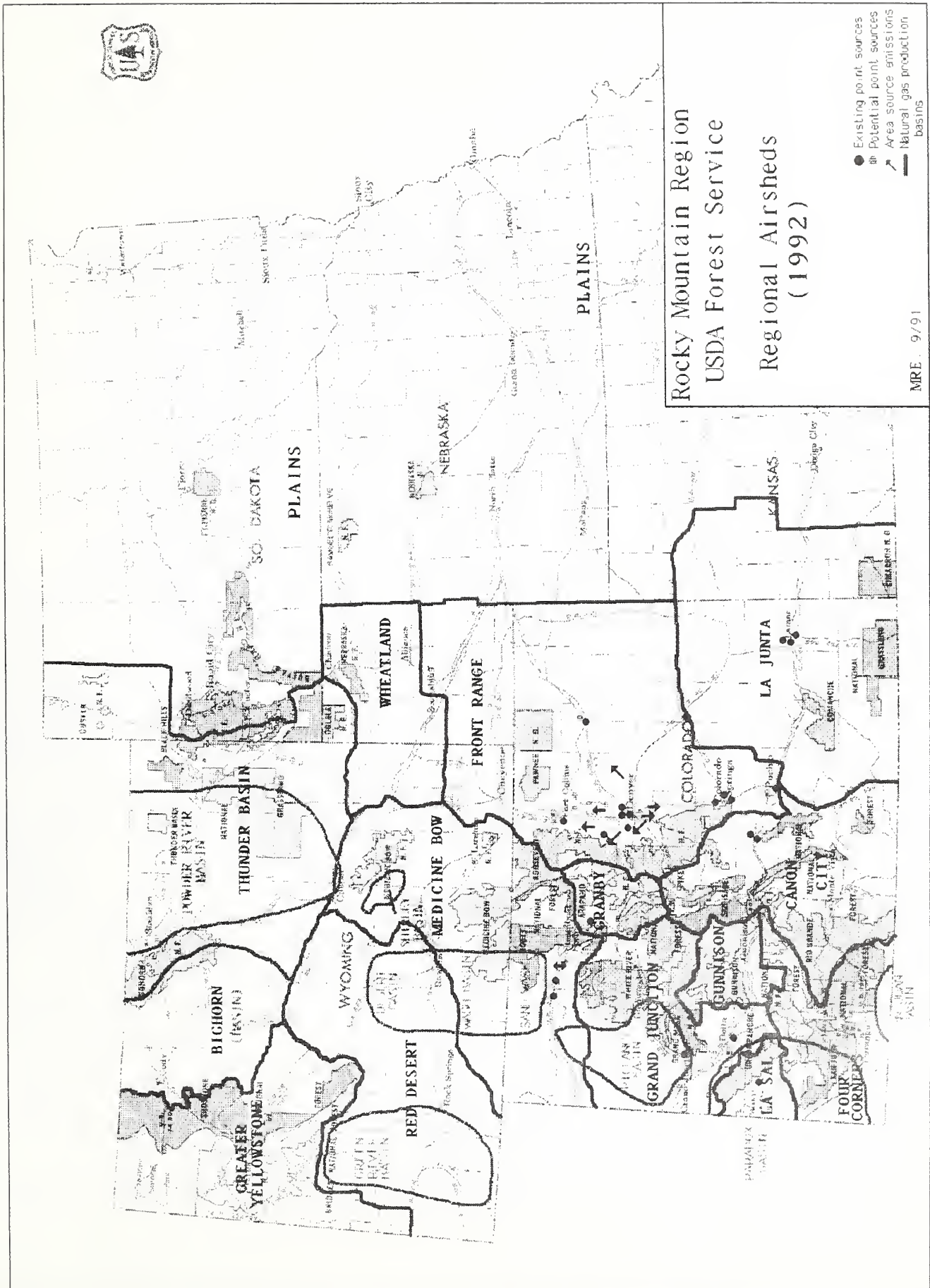
#### STAFFING RECOMMENDATIONS

For Regional Air Resource Management programs to be most effective, Forests need to coordinate with each other within and outside airshed, Forest, and Wilderness boundaries. Monitoring efforts can often be conducted to benefit two or more Forests at once, conserving effort and funds. Air Resource "zone" positions shared between Forests could greatly facilitate this process:

1. The San Juan and Rio Grande NF's have existing monitoring that benefits both Forests, and southwest airflows result in similar long-range emissions impacts in the Four Corners and Canon City airsheds. These Forests could benefit by sharing a full-time Air Resource Specialist zone position.
2. Impacts on Front Range NF lands have not been adequately addressed in the past, despite a large number of pollution sources in the vicinity. The Pike, San Isabel, Arapaho, and Roosevelt NF's all deal with Front Range air pollution effects, and an Air Resource Specialist zone position here is also recommended. This person could coordinate air resource monitoring and other related issues between all four Forests in this airshed, and in adjacent airsheds covered by the Forests as needed.
3. The Routt and White River National Forests could combine forces for an Air Resource zone position to cover the airsheds in northern Colorado. This recommendation is based more on administrative considerations (location and workload of Forest air quality responsibilities) than airshed considerations.

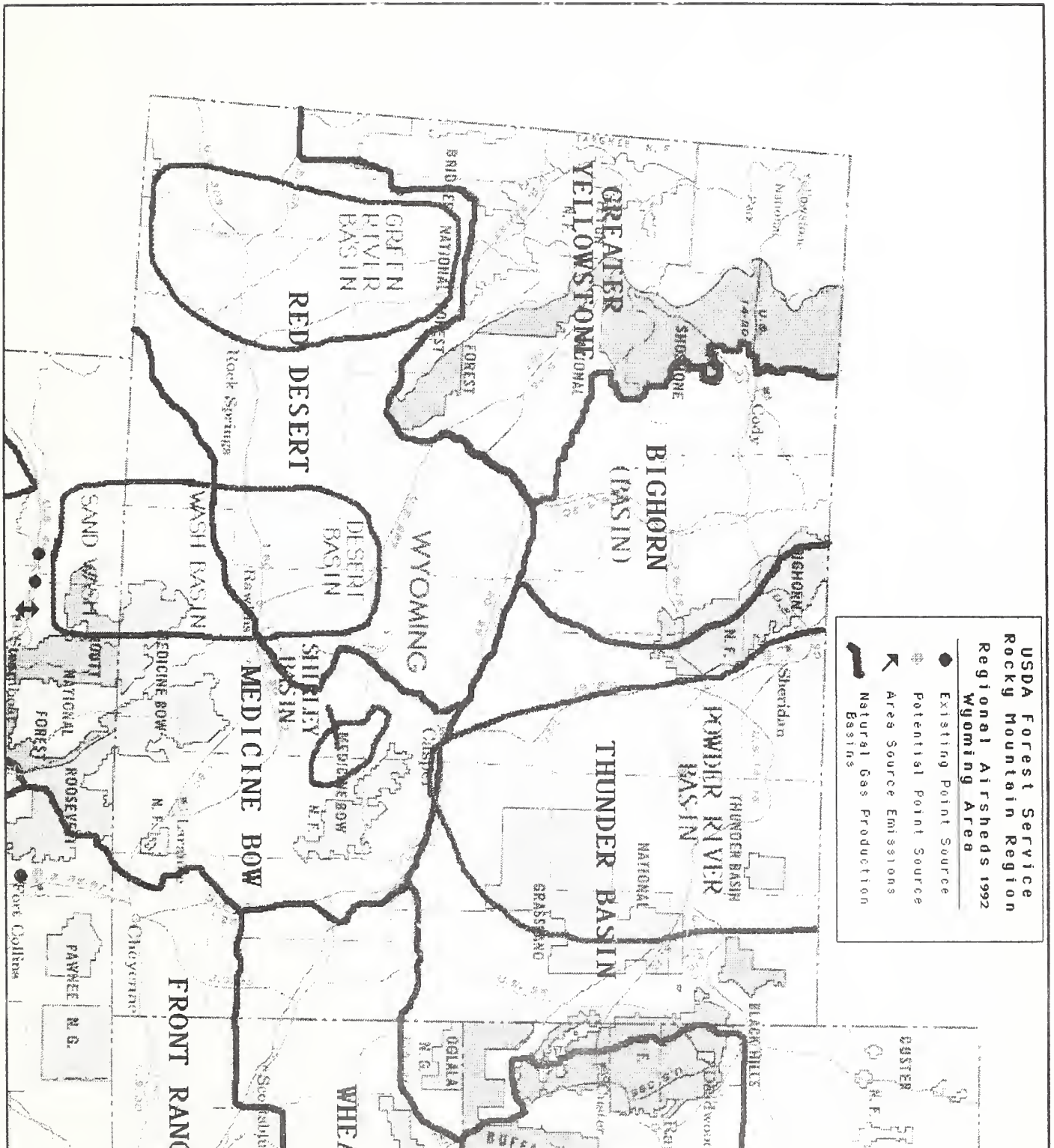


Appendix 3-1a  
**REGION 2 AIRSHED OVERVIEW**  
 (Detailed Maps Follow on Next Three Pages)

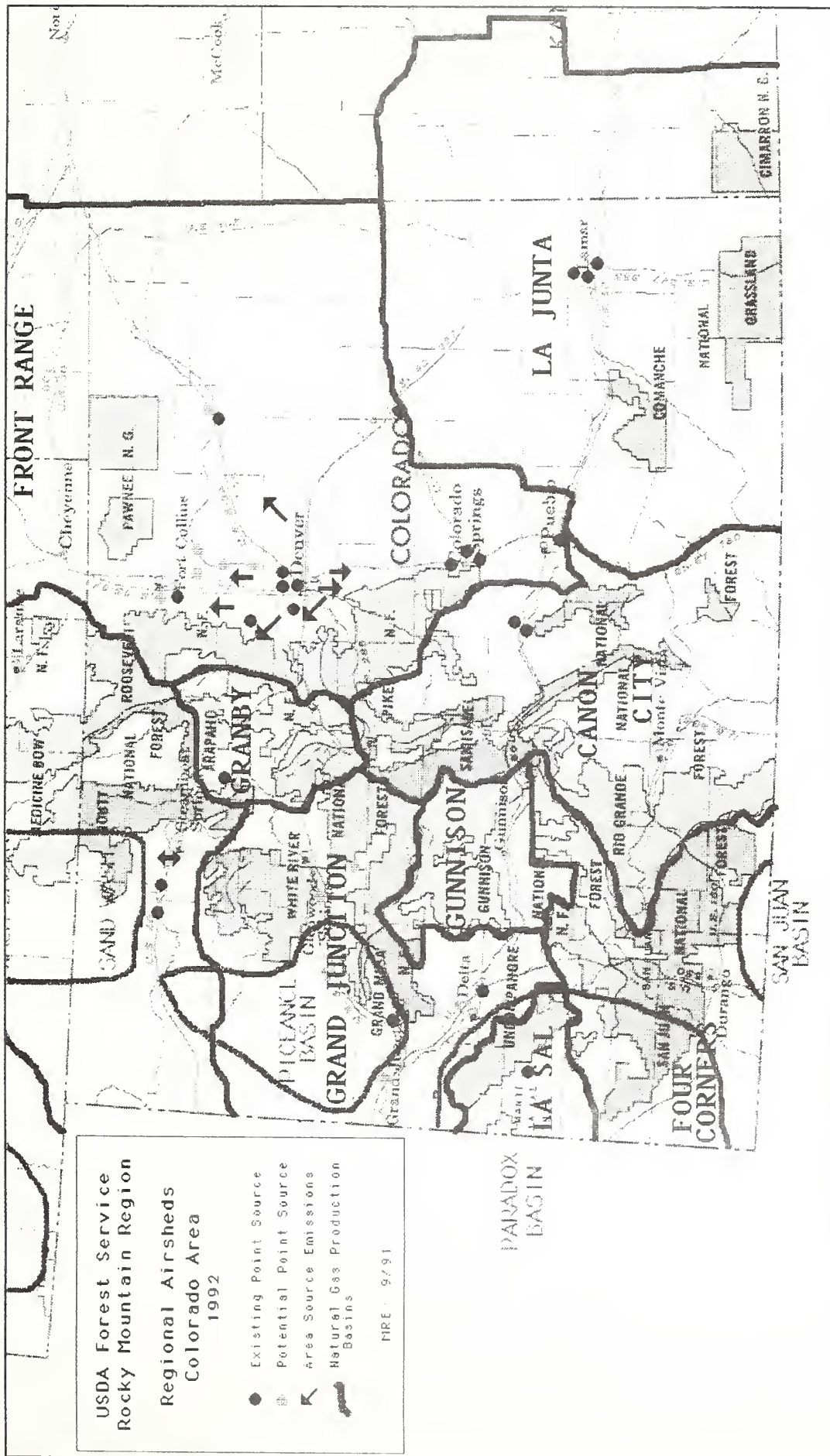




REGION 2 AIRSHEDS: WYOMING AREA



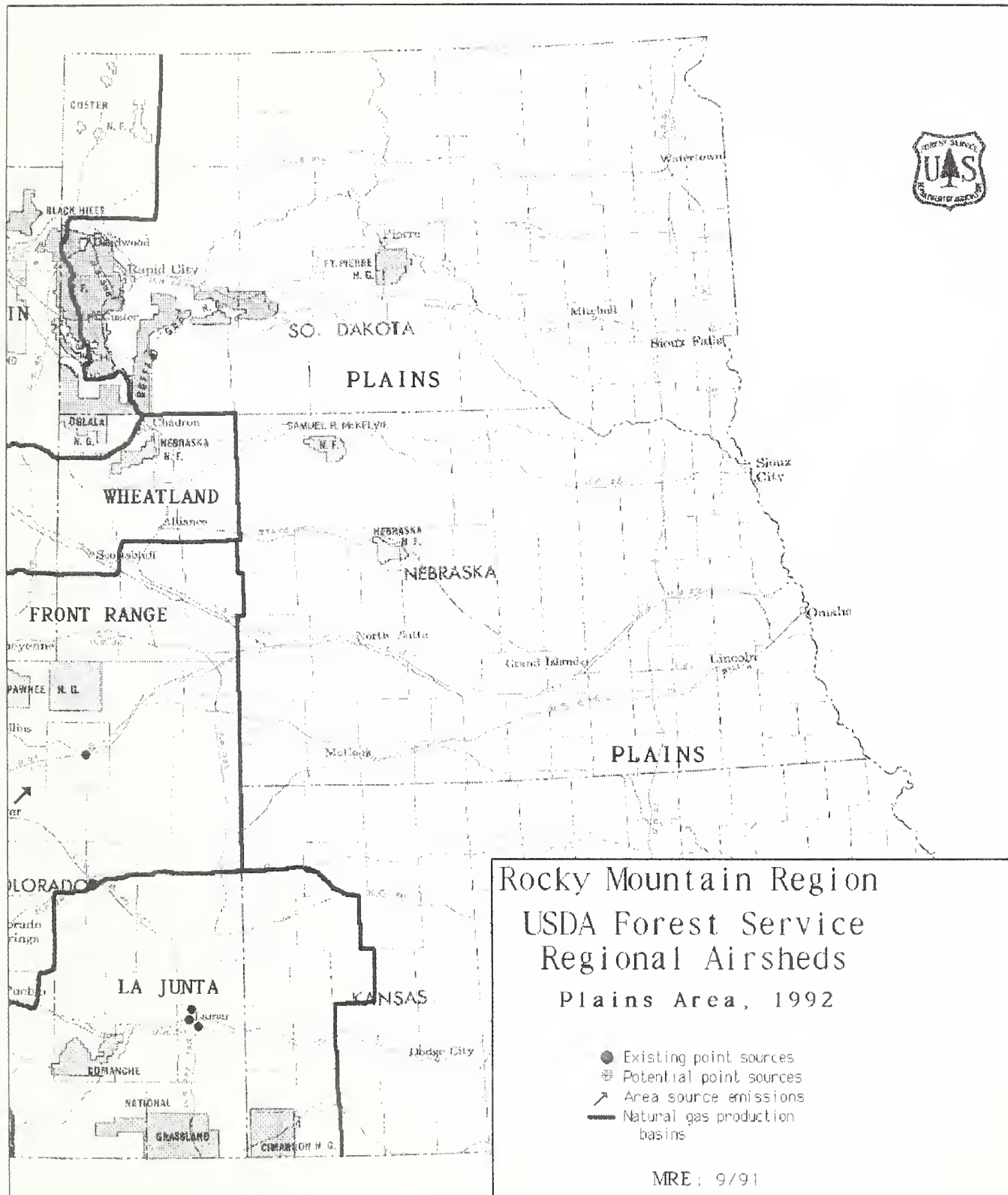






# Appendix 3-1d

## REGION 2 AIRSHEDS: PLAINS AREA





Appendix 3-2

January, 1992

POLLUTION SOURCES POTENTIALLY AFFECTING REGION 2 WILDERNESS AREAS

<u>Airshed</u>	<u>Source Type</u>	<u>Location</u>	<u>Pollutant Info</u>	<u>Expected Change</u>
Bighorn	Oil & Gas	SW Wyoming	NO <sub>x</sub> , SO <sub>2</sub> , H <sub>2</sub> S	none
Canon City	Cement Plant	9 mi SE of Canon C.	3000 TPY SO <sub>2</sub> 660 TPY NO <sub>x</sub>	none
Canon City	Power Plant	Canon City	1200 TPY SO <sub>2</sub> 900 TPY NO <sub>x</sub>	none or decreasing
Canon City	Oil & Gas	San Juan Basin	NO <sub>x</sub> , CO	increasing
Canon City	Regional Haze	SW USA	Variable	increasing
Four Corners	Oil & Gas	San Juan Basin	NO <sub>x</sub> , PM, some SO <sub>2</sub>	increasing
Four Corners	San Juan Power Plt	Fruitland, NM	SO <sub>2</sub> , NO <sub>x</sub>	none
Four Corners	4Corners Power Plt	Fruitland, NM	SO <sub>2</sub> , NO <sub>x</sub> , PM	decreasing
*Four Corners	Power Plant	New Mexico	SO <sub>2</sub> , NO <sub>x</sub> , PM	likely
Four Corners	Regional Emissions	SW USA	Variable	none
Front Range	10 Power Plants	(Co Sprgs, Denver, Brush, Ft.Col, Pueblo, Boulder)	SO <sub>2</sub> , NO <sub>x</sub>	none or decreasing
*Front Range	5 Power Plants	Variable	NO <sub>x</sub> , SO <sub>2</sub>	increasing
*Front Range	Cement Plant-Incin.	La Porte, CO	NO <sub>x</sub> , SO <sub>2</sub>	unknown
Front Range	Coors Brewery	Golden, CO	NO <sub>x</sub> , SO <sub>2</sub>	decreasing
Front Range	Oil & Gas	Weld, Adams CO	NO <sub>x</sub> , PM	none
Front Range	Regional Emissions	Metro Denver	NO <sub>x</sub> , SO <sub>2</sub> , PM, VOC	decreasing
Granby	Regional Haze	SW USA	Variable	none
Granby	& Some Local Area & Mobile	Ski Areas	NO <sub>x</sub> & PM PM & Dust	none or decreasing none or increasing
Grand Junction	Agr. Burning	Variable	PM	none
*Grand Junction	W. Slope Refining	Fruita	<1000TPY SO <sub>2</sub>	restart - old plant
Grand Junction	Area Sources	Grand Jct Area	Variable	increasing
*Grand Junction	Unocal-Shale	Piceance Basin	SO <sub>2</sub> & NO <sub>x</sub>	decreasing
Grand Junction	Cameo Power Plant	Cameo	SO <sub>2</sub> , NO <sub>x</sub>	none
Grand Junction	Louisiana Pacific	Olathe	NO <sub>x</sub> , PM, VOC	decreasing
*Grand Junction	CoGen Plant	Glenwood area	300TPY NO <sub>x</sub>	long shot
Grand Junction	Regional Emissions	Aspen/Glenwood Spr	Variable	increasing
*Grand Junction	Power Plant	Carbondale	Waste Coal Prod.	long shot
Gr. Yellowstone	Oil & Gas	Riley Ridge, Big Piney, LeBarge	SO <sub>2</sub> , NO <sub>x</sub>	increasing
Gr. Yellowstone	Regional Haze	SW USA	SO <sub>2</sub> , NO <sub>x</sub> , Tr.Metals	increasing
*Gr. Yellowstone	Gold Mine	Near Beartooth	PM, Dust	none
Gunnison	Regional Haze	SW USA	Sulfate, Nitrate	increasing
La Junta	Power Plants	Near LaMar	NO <sub>x</sub> & SO <sub>2</sub> (100TPY)	none
La Sal	Nucla Power Plant	Nucla	NO <sub>x</sub> & SO <sub>2</sub>	increasing
Medicine Bow	Oil & Gas	Meeker, Rangely	SO <sub>2</sub> , NO <sub>x</sub>	increasing
Medicine Bow	Mineral Development		Dust	increasing
Medicine Bow	Moon Lake Power Plt	Bonanza, Utah	SO <sub>2</sub> , NO <sub>x</sub>	none
Medicine Bow	Craig Power Plt	Craig, CO	SO <sub>2</sub> , NO <sub>x</sub>	none
Medicine Bow	Hayden Power Plt	Hayden, CO	SO <sub>2</sub> , NO <sub>x</sub> , PM	increasing
*Medicine Bow	Catamount Ski Area	Steamboat, CO	PM, VOC	increasing
*Medicine Bow	C-B Oil Shale	Piceance Basin	SO <sub>2</sub> , NO <sub>x</sub>	long shot
*Medicine Bow	Mining, Gas Devel.	Piceance Basin	NO <sub>x</sub> Compressors	long shot
Medicine Bow	Reg Emmissions	SLC, Vernal, Rock Spr, Evanston	Variable	none
Thunder Basin	Oil & Gas	Billings, MT	SO <sub>2</sub> , NO <sub>2</sub>	none or increasing
Thunder Basin	Coal Fields	Powder River Basin	PM	none
*Thunder Basn	Texaco Power Plt	Near Cloud Peak	SO <sub>2</sub> , NO <sub>x</sub>	likely
Wheatland	Coal Power Plt	Wheatland, WY	SO <sub>2</sub>	none

\* indicates a proposed source, not a current one

TPY = Tons Per Year



REGION 2 AIR RESOURCE  
MONITORING





## CHAPTER 4: REGION 2 AIR RESOURCE MONITORING

### INTRODUCTION

The purpose of this section is to discuss monitoring of terrestrial and aquatic ecosystems, visibility, air chemistry, and atmospheric deposition. The chapter will explain why each of them is susceptible to air pollutants; review what kind of monitoring has been done in the Region, and where; and describe how these data may be used, either in the regulatory process or to evaluate ecosystem health. Some of the subcategories of AQRV's most likely to be impacted within Region 2 will be addressed (lichens, lake chemistry, amphibians, etc.). The individual Forests, however, will have to identify the specific sensitive receptors (the components of the system through which change can be measured, i.e., the alkalinity of Lost Lake, sensitive lichen species of the Flat Tops Wilderness, etc.) within their Wildernesses, and may also have to consider monitoring additional subcategories of AQRV's in their area.

Available models are also discussed, as much of the data collected will be used as model input to predict impacts to AQRV's, should a PSD source be permitted. It is not anticipated that this chapter will provide detailed enough information to enable a Forest AQ specialist to initiate monitoring immediately. Instead, this chapter should be considered an overview, offering background information and an overall context with which to plan more specific monitoring.

The Forest Service is responsible for preventing degradation of its Wilderness ecosystems. We are required by law to be able to predict any potential pollution-caused change of AQRV's before the degradation actually occurs. The monitoring of AQRV's, therefore, has two main objectives: to determine general ecosystem health related to air pollution impacts, and to gather data for use in the Prevention of Significant Deterioration (PSD) permit process.

There is no standard set of information used in the PSD process. The data presented at any given hearing will be determined by the type of pollutant source applying for a permit, the distance of the source from the Wilderness, prevailing wind directions, the sensitive receptors that are judged to be at risk, and any issues of special concern to the public. The dilemma for the Forest Service is that several years of data must often be collected to determine the "baseline" condition of the resource, before the impacts that a new source might have can be modeled or projected. This information, however, may be required for making decisions in the PSD process with as little as 30 days' notice. Therefore, we must anticipate far in advance what data will be most useful in future PSD hearings, and plan monitoring efforts accordingly.

The AQRV's discussed in this section were selected based on the following considerations:

1. Their known or suspected sensitivity to atmospheric pollutants.
2. The availability of logistically manageable, cost-effective sampling and analysis methods.
3. The availability of models or predictive techniques for estimating the ef-

fects on the sensitive receptor of proposed increases in emissions.

To advise the Forest Service on how best to address PSD requirements in designing its monitoring programs, a workshop of interested scientists, federal land managers, state air regulators, industry representatives, and private citizens was held in Estes Park, CO, in December, 1990. Their monitoring recommendations are presented in this chapter, to help guide Forests' future monitoring efforts, and their recommendations concerning Limits of Acceptable Change are presented in Chapter 6. Available funding and internal priorities, however, will determine the feasibility of implementing any of these recommendations.

Both air-chemistry and atmospheric-deposition monitoring are covered, in addition to AQRV monitoring, to help establish the link between air pollution and any changes in the physical, chemical, or biological condition of the sensitive receptors.

#### **ESTABLISHING A FOREST MONITORING PROGRAM**

The Rocky Mountain Region contains many thousands of lakes that are important parts of mountain watersheds, contain crucial wildlife habitat, and are an essential part of the backcountry experience for many. Assessing the effects of pollutant emissions on aquatic ecosystems requires some understanding of the processes that control the chemistry and biology of each lake.

To design an aquatics monitoring program, maps, journal articles, and books that describe the geologic, hydrologic, biotic, or other characteristics of the Wilderness may be useful. For example, since aquatic chemistry is very dependent on geology, knowledge of the bedrock composition of a Wilderness can guide the search for its most susceptible aquatic systems. If possible, the manager of each Wilderness should project the most likely future sources of emissions, in addition to assembling a map of present sources, the prevailing wind direction, and any other characteristic that can help describe the most probable areas of greatest pollutant deposition and sensitivity.

An aquatics monitoring program often begins with a synoptic survey to identify sensitive aquatic ecosystems. Such a survey can also help to identify vulnerable aquatic or terrestrial organisms associated with the aquatic systems, and can often yield information used to select the most sensitive aquatic ecosystems for long-term monitoring used in predicting, modeling, and monitoring potential effects for the PSD process.

Ideally, to obtain the best picture of lake chemistry in a Wilderness, all of its lakes should be sampled. When this is not practical or possible, the most sensitive lakes should be sampled (see the "Water" subsection, following). Representative samples can also be collected by assigning lakes to some common characteristic (such as bedrock geology and altitude) and collecting a random sample from within these groups of characteristics. This is a statistically desirable approach, but does not take into account problems of access or efficiency in moving from one selected lake to another. To ensure the quality of data and enhance the comparability of results among Wilderness Areas within a region, it is recommended that experts be consulted on how best to initiate monitoring for each Wilderness. Because such data may have to be defensible in court, it is critical that generally accepted methods be used and documentation of all steps of data collection and analysis be made. Region 2 has developed

protocols to use in collecting lake-chemistry samples; these are available upon request from Tamara Franklin in the Regional Office.

To help Forests plan more detailed inventorying and monitoring of Wilderness air pollution and AQRV's than the general overview in this section describes, the Region has developed the following guidelines:

1. Identify the sensitive receptors, if any, for each AQRV.
2. Assess their existing physical, chemical, and/or biological condition.
3. Determine if existing air pollution is affecting the receptors in these aspects.
4. Establish a data base to use in the regulatory process, with which to predict the effects of proposed air pollution sources on the receptors.

Monitoring needs to be specific in terms of its objectives, methodology (what, when, where, and how often it is conducted), and desired precision and reliability. The data must be of high quality in order to sustain critical review in the PSD process. Quality-assurance and quality-control (QA/QC) procedures should be specified for data collection, analysis, interpretation, and reporting. Also, a safety plan may be needed to meet internal FS requirements.

#### MONITORING THE AIR POLLUTION IMPACTS OF FIRE

Smoke from wildfires and prescribed burns has the potential to impair visibility in all of the Region's airsheds, even from hundreds of miles away. For example, the 1987 California fires affected visibility in much of southern Colorado; in 1988, the Yellowstone fires caused significant visibility problems in Wyoming and South Dakota. Because of the temporary, intermittent, and unpredictable nature of wildfire, a specific visibility monitoring strategy is not proposed. Visibility monitoring strategies proposed for stationary and area sources, however, will help measure wildfire's impact.

Prescribed fire can cause visibility impairment both on and off National Forest System lands. Because of its predictability, controlled burning is much easier to monitor than wildfire. Forests will need to determine their prescribed-burning activities' potential for impairing visibility and develop specific monitoring strategies accordingly.

#### TERRESTRIAL ECOSYSTEMS

The sensitive component of terrestrial ecosystems most easily monitored in this Region is flora. This chapter will briefly examine flora in terms of its sensitivity to air pollutants and its role in AQRV monitoring. As with any other component of an ecosystem, a particular assemblage of species forms a characteristic community dependent on environmental conditions, which can change when stressed.

The lichen community is a good example of flora that can contain sensitive receptors to atmospheric deposition. It is well established that certain lichens are vulnerable to, and can serve as monitors of, air pollution.<sup>2</sup> Many physiological and structural factors contribute to this: lichens have no protective

cuticle to serve as a barrier to material from the atmosphere, they absorb most of their nutrients and water directly from the atmosphere, they have a high retention capacity and accumulate elements, and they are long-lived.

Recent research has explored many effects of atmospheric pollution on susceptible lichen species. These can include changes in color; decrease in size; plasmolysis of algal cells; decreases in respiratory, photosynthetic, and nitrogen-fixation rates; decrease in growth rate; damage to plasma membrane; increase in cytoplasmic concentration of mineral elements including sulfur; chlorophyll degradation; and changes in pH, conductivity, and potassium efflux. Most research relevant to field monitoring of lichen has centered around  $\text{SO}_2$  effects and accumulation of metals.

FS monitoring of lichens has generally concentrated on three topics:

1. Identifying all lichen species known to occur in an area.
2. Monitoring pollutant-sensitive species (with plots or transects), to detect changes in species composition.
3. Elemental analysis, to quantify the amount of toxic elements and important nutrients present in lichen tissue.

Lichen taxonomy is complex. To inventory the lichen community initially, expert assistance is required. Subsequent inventory may be conducted by FS field personnel, if thorough documentation and photographs are collected following the initial field survey. In Region 2, lichen surveys were conducted in the Flat Tops Wilderness in 1982. Seven species were designated as "indicators," either because of their known sensitivity to air pollution or their value as bioaccumulators. Element analysis was conducted on each of them. A survey of these same plots, along with new element-analysis measurements, is scheduled for 1992, to determine whether any change has occurred over the ten years.

Vascular plants are a second subcategory of AQRV's for flora. Generally, they include riparian species, conifers, and deciduous plants. Ozone and sulfur dioxide ( $\text{SO}_2$ ) are usually considered to be the pollutants most likely to affect them. Although there has been extensive research on their sensitivity to air pollutants, much of the work has focused on identifying extreme air pollution symptoms found in plants and trees in the eastern U.S. and California.<sup>3</sup> Not much information is available on pollutant effects on the types of ecosystems found in Region 2's high-elevation Wilderness areas,<sup>4</sup> and no complete lists of vascular plants have been compiled for the Region. (Currently, the Rocky Mountain Herbarium at the University of Wyoming is conducting a floristic study in the Flat Tops Wilderness, which will include herbaceous plants, shrubs, and trees, with an emphasis on rare and endangered species. The study is expected to be completed this year. Also, the University of Colorado, Boulder herbarium is conducting a floristic study in the Eagles Nest Wilderness. Its emphasis is also on rare and endangered species; the expected completion date is 1992.)

Information about lichens and vascular plants can be used to address the following questions which are important in the PSD permit process:

1. Is there a trend in the accumulation of trace metals in lichens?
2. What is the natural variation and current condition of sensitive flora in Region 2?

3. Will increases in deposition affect the condition of any of these flora?

Terrestrial ecosystems can be impacted by changes in acidic deposition and air chemistry, but the effects are difficult to measure and in some cases unknown. Baseline monitoring must be conducted for several years to determine the range of natural variation, and additional information will be needed from the research community to determine responses to incremental changes in deposition and air chemistry.

**RECOMMENDED PRIORITIES FROM THE ESTES PARK SCREENING MEETING: TERRESTRIAL ECOSYSTEMS**

1. Acquire baseline information immediately. Baseline needs listed in the table of LAC's for Terrestrial Ecosystems in Chapter 6 are not necessarily exhaustive, but include measurements of community composition (both plants and animals); tissue chemistry; distribution and abundance of threatened, endangered, or sensitive species; soil properties such as cation exchange capacity; elemental content of organic matter; condition of important cultural features; and other properties likely to be adversely affected by pollutants.
2. Use established field and laboratory techniques, including updated QA/QC methods. Employ experts or specialists where needed (for example, lichenologists).
3. Keep the monitoring as simple as possible, but don't degrade monitoring just because more complicated techniques may be necessary. Remember, monitoring is a service to future managers and publics.
4. Design the monitoring system regionally; implement the system locally.
5. Incorporate in the design as many replicate samples as necessary to permit some degree of statistical interpretation in the future. Document field plots and samples thoroughly. Keep in mind that invariably some plots will get lost or otherwise become useless in the future, so there is a need to build redundancy into the system.
6. Make use of photographic reference points as often as possible, making sure they are well documented and relocatable.

**AQUATIC ECOSYSTEMS**

The EPA considers "sensitive" lakes (with limited ability to buffer any incoming acidity) to be those with alkalinities below 200 ueq/l. Elements of aquatic ecosystems that may be sensitive to acidic deposition include aquatic flora and fauna, soils, lake and stream chemistry, snowpack chemistry, and snowmelt. In addition to monitoring sensitive aquatic systems, the measurement of atmospheric inputs to the aquatic ecosystem is critical. This can include snowpack chemistry and wet deposition. Data on the watershed characteristics needed to run any selected models must be obtained. Changes in watershed chemistry over the last century or longer can be evaluated using paleolimnological methods.

## FLORA AND FAUNA

**Plankton** are widely dispersed, free-floating microscopic organisms that reproduce rapidly. These characteristics often allow changes caused by ecosystem stress to be seen and quantified at an earlier stage than with larger organisms. Certain crustaceous zooplankters (animal plankton) are very vulnerable to environmental stress; for instance, a single female of *Daphnia* sp. has the potential to leave 13<sup>10</sup> descendants in 60 days, yet a minor imbalance of the system can lead to sudden local disappearance of the species.<sup>6</sup> Phytoplankton (plant-related plankton, like algae<sup>7</sup>) can display significant change in composition in as little as two weeks. Recent research has indicated that both phytoplankton and zooplankton can serve as indicators of acidification.<sup>8</sup>

In addition to species changes, acidification may affect a lake's food chain. Phytoplankton are primary producers in the food chain, and zooplankton are intermediary. Disruptions of these portions of the food chain may lead to widespread injury at higher levels, as aquatic species are deprived of their customary food sources. Research is lacking on the plankton-community dynamics of high-altitude lakes; studies to measure and identify which species are present are ongoing in lakes in the Rocky Mountain National Park and the Snowy and Wind River Ranges of Wyoming.<sup>9</sup>

One of the difficulties of plankton monitoring is that variability within a species may be large from year to year, and even month to month.<sup>10</sup> For example, in 1983, phytoplankton and zooplankton samples were collected from Ned Wilson, Oyster, and Upper Island Lakes in the Flat Tops Wilderness by the USGS.<sup>11</sup> These biotic data may be useful for comparison with future samples, but they do not really provide a "baseline," because several years of sample collection are necessary to learn the range of natural population variability by season and year. Another drawback is that plankton samples must be taken from the deepest point of a lake, so rafts and associated equipment need to be packed in and/or cached in the Wilderness.

**Amphibians** also can be susceptible to air pollution, because their distribution and breeding success can be affected by low pH.<sup>12</sup> Four species (tiger salamanders, chorus frogs, leopard frogs, and wood frogs) may be present (i.e., suitable habitat exists) in many of the Region's Class I Wilderness areas. They seem to be declining in western Colorado, but it is uncertain if this is the result of man-caused environmental acidification or natural fluctuations in population.<sup>13</sup>

The Fish and Wildlife Service has been monitoring breeding and non-breeding amphibian populations in much of Colorado. Ongoing research at the Rocky Mountain Biological Laboratory suggests that tiger salamander populations may have been affected by changes in pH in Western Colorado lakes.<sup>14</sup>

Information about aquatic ecosystems will be used to address the following regulatory questions:

1. What is the natural variation and current condition of sensitive aquatic species?
2. What changes in the diversity and abundance of amphibians can we expect to occur with changes in aquatic conditions, if deposition increases?

## SOILS

Soil is listed here as a component of aquatic ecosystems because it is a crucial component of the biogeochemical cycling process, and it can trap or buffer pollutants in run-off water before they enter the aquatic system. The buffering ability and present condition of the soils in each area may be assessed to determine what influence they have on lake chemistry. The data needed to determine buffering ability include soil mineralogy, identification of soil horizons, metal and organic matter content, pH, effective depth, texture, bulk density, porosity, drainage, and percent of coarse-fragment material.

The sulfate-absorption capacity, absorbed sulfate, cation-exchange capacity, base saturation, and nitrogen content should also be determined, to establish soils sensitivity. In conjunction with the lake-chemistry information collected at these sites, the soil data can be used in watershed models to predict the impacts of increased source emissions on lake chemistry.<sup>15</sup> It will also aid in the interpretation of the lake- and snow-chemistry data.<sup>16</sup>

Because soils buffer acidic inputs to surface waters, general soils information is needed for each watershed where sensitive lakes are monitored. This will be used to address two questions important in the PSD permit process:

1. What is the current chemical and structural condition of Forest soils?
2. Will increases in deposition affect the ability of the soils to buffer lakes from acidic inputs?

To incorporate soils information in watershed-deposition scenarios, the "Aquatics" group at the 1990 Estes Park Screening Meeting recommended a model known as MAGIC (Model of Acidification of Groundwater In Catchments). Developed at the University of Virginia, it has been used to estimate watershed-acidification parameters for the Forest Service in Idaho, Montana, and Wyoming. The minimum soils information needed to run the model includes the analysis of several individual samples of some specific soil horizons (O, A, B, C), noting the depth at which each sample was collected.

The soil samples should be collected from the area where most of the watershed runoff occurs, and their location recorded on a map. Soils analysis should include texture, bulk density, base saturation, CEC, Ca, Mg, Na, K,  $SO_4$ , absorption, and pH. Depth of soil is a very useful measurement, and can be approximated by inserting a metal rod into the soil. A few small rock samples should also be collected at the watershed site, to confirm the watershed mineralogy. Photographs (labeled and dated) should scan the watershed, the lake, and the lake inlet and outlet. These are very helpful in resolving questions that arise during the estimation of model variables.<sup>17</sup>

## WATER: LAKE AND STREAM CHEMISTRY, SNOWPACK CHEMISTRY, AND SNOWMELT

This monitoring program is directed at finding and monitoring aquatic systems vulnerable to acid deposition; however, these systems are not necessarily the most susceptible to other possible threats (i.e., heavy lakeside camping, dumping of toxics into streams, etc.). Consequently, monitoring efforts for different objectives should be designed and implemented using different guidelines.

Lake sensitivity is mainly a function of bedrock geology and hydrology, but can also be influenced by other factors, such as climate, land use, and disturbance (natural or man-made disruptions).

The lakes most vulnerable to acidification are those on any one of the slow-weathering bedrock types common in the Rocky Mountain region, (quartzite, quartz monzonite, granite, or basalt). These bedrock types result in minimal lake acid-neutralizing capability (ANC) because of slow rates of weathering per unit area of mineral. The most susceptible lakes will have minimal amounts of material that can form the matrix of an aquifer, such as glacial till, glacial gravel, or alluvium. These materials not only provide a large surface area per unit volume for mineral dissolution and ANC production, but also a continuous flow of ANC into a lake or stream. The most sensitive lakes probably will be found at the beginning of hydrologic flow paths (e.g., higher elevations such as saddles, cirques, and mesa tops), rather than farther along them. Longer flow paths provide additional time for the reaction between ground water and the minerals that dissolve to produce ANC.

**Lake and stream chemistry** can be profoundly impacted by changes in acidification, but these effects are difficult to quantify and document. Baseline monitoring must often be conducted for several years to determine the range of species variability under natural conditions. Only when baseline levels have been established can change due to acidic deposition or other pollution effects be assessed or predicted. Long-term monitoring sites are necessary both to detect trends caused by man and to define the limits of the natural variability in the chemical and biotic characteristics of the aquatic system. Such variation is a function of season, climate, and natural succession, as well as the emissions effects we would like to define. Thus, long-term monitoring in advance of a new emissions source is necessary to define how large a change is needed to qualify as statistically significant within the natural background variations.

The purpose of an ongoing monitoring effort is to determine the natural variance and possible trends in chemistry of precipitation, lakes, and springs. Data and information from the stream- and lake-chemistry monitoring program can be used to address the status of aquatic resources; the sensitivity of these resources to change; and the trends, amount, and type of change in lake and stream chemistry. It is important to consider buffering capacity, flushing rates, and watershed sulfate sources, to ascertain if sulfate amounts in a given lake are coming from man-caused emissions.

There have been several lake-monitoring efforts in Region 2 in the past ten years:

1. The Western Lakes Survey, conducted by EPA in 1985, was a one-time stratified random-sampling effort, characterizing lake chemistry on a large scale. It was not intended to find the most vulnerable aquatic systems, although there may be sufficient data from some areas to define the prevalence of susceptible aquatic systems.
2. The Environmental Monitoring and Assessment Program, which is being initiated by EPA. Approximately 800 lakes per year will be sampled nationally, with sampling at individual lakes being repeated every five years. As with the Western Lake Survey, sampling is random rather than focused on sensitive systems.

3. The Hydrologic Benchmark Program of the USGS, operating since about 1966. Several of these watersheds drain western Wilderness areas.
4. Long-term lake-sampling programs conducted by John Turk of the USGS since 1985-86 in the Flat Tops, Mt. Zirkel, and Weminuche Wildernesses.
5. Sampling programs conducted by universities or as short-term projects by agencies such as USGS, FS, BLM, NPS, F&W.

Water-chemistry monitoring is a long-term commitment and must be funded accordingly. Sample years cannot be skipped if trends are to be detected. Lack of existing data on lake chemistry will require sampling lakes in an initial inventory and identifying those which would be sensitive receptors. (See Appendix 1 for a discussion of available aquatic-ecosystem models, based on the findings of the "Aquatic Ecosystems" section at the 1990 Estes Park Screening Workshop.)

**Snowpack chemistry** reveals the winter accumulation of atmospheric deposition in the snowpack. The ion content of a snowpack remains relatively stable prior to initial snowmelt.<sup>19</sup> Research suggests the first 10-20% of spring snowmelt water may contain 50-70% of the acid-rain material<sup>20</sup> in the snowpack, resulting in an "acid pulse" being released into the watershed.

**Snowmelt** may cause changes in hydrologic flow paths that can temporarily decrease the buffering ability of lakes. This can occur when water has less contact with the soil or bedrock. For example, saturation of soils during snowmelt may cause much of the flow to occur as overland flow. As the summer progresses, less soil is saturated and more water can flow through the soil, gaining buffering potential as contact with soil and bedrock increases.

Snowmelt chemistry monitoring can indicate condition and change (e.g., acid stress) that may impact aquatic biota in lakes and watersheds. Snowmelt chemistry has been monitored at some high-elevation lakes in Colorado and Wyoming (Glacier Lakes, Loch Vale, Ned Wilson) but requires intensive sampling efforts during the snowmelt season in order to catch the "pulse" while it occurs. This level of effort usually requires helicopter support (for automatic sampling equipment) or intensive personnel requirements (daily sampling for up to a month), in dangerous conditions -- snowmelt season is often avalanche season. Thus the difficult logistics of this type of sampling may limit the number of lakes that can be tested.

#### **RECOMMENDED PRIORITIES FROM THE ESTES PARK SCREENING MEETING: AQUATIC ECOSYSTEMS**

1. The FS needs to make a commitment in each Forest Plan and Wilderness implementation schedule to long-term monitoring of sensitive receptors.
2. The watershed model MAGIC is recommended to predict emissions impacts on aquatic systems. The data necessary to calibrate MAGIC need to be collected for each long-term monitoring site.
3. Synoptic sampling is recommended for each Wilderness Area, to define the

presence and distribution of sensitive receptors. This sampling needs to be guided and coordinated by a regional team of experts to ensure quality and comparability.

4. Each Wilderness needs to define the seasonal and yearly variability of sensitive receptors, especially episodic effects during snowmelt. These results should be used to estimate the sampling frequency need to identify changes addressed by Limits to Acceptable Change.
- 5) Each Wilderness Area needs to have a yearly snowpack sampling of the amount and chemistry of water.
- 6) Each Wilderness Area needs an archive collection of diatoms (for later population analysis), hair (to document toxics concentrations), and other characteristics that may be used in the future to define the pre-source conditions of the Wilderness.
- 7) Paleolimnological sampling should be initiated in each Wilderness Area, to determine how present and "natural" conditions differ.

The data and information from the lake- and snow-chemistry monitoring program can be used to address the effect of present and projected sulfate deposition and sulfur on lake chemistry, the effect of present and projected nitrogen deposition and nitrogen on lake chemistry and biomass production, and the natural variations and current conditions in lake and snowmelt chemistry.

#### VISIBILITY

A view of the scenery through "clean, fresh air" has been shown in several surveys to be the most important Wilderness attribute to Wilderness users in Colorado.<sup>21</sup> Providing a natural visual experience is thus a high priority for the Forest Service in Region 2.

Visibility monitoring can be divided into three categories: photographic documentation, trend monitoring, and special emission-source studies. The type of monitoring depends on the specific objectives. **Photographic documentation** may be useful to demonstrate qualitatively the existence of a visibility problem deserving additional monitoring, analysis, and remediation. For this objective, photographs taken with an automated system over at least one year may suffice. **Trend monitoring** is needed to document what a "baseline condition" might be, or to establish changes in visibility over time. To document trends, atmospheric optical parameters, particle concentrations, particle size, and chemical composition can be monitored. Trend monitoring must be continuous over many years; in some cases, more than ten years of data may be required to identify trends, because of year-to-year variability in meteorological conditions. **Special emission-source studies** can document pollution impacts on Wilderness areas and determine exactly where the pollution originated. This type of study can then be used to furnish regulatory agencies with the necessary technical information to support source retrofitting and other air pollution cleanup activities.

Of the three types of visibility monitoring, trend monitoring is the most prevalent, because it demonstrates changes in visibility over time. It may consist of three elements:

1. **View monitoring** can be achieved using photographic records to illustrate changes in air quality. Views of given vistas in color slides, taken by automated cameras at least three times a day (at 0900, 1200, and 1500), are the sensitive receptors. The contrast between the target (for instance, a mountain in the distance) and the horizon will be the parameter measured. From this contrast measurement "Standard Visual Range" (SVR) can be calculated. This allows nationwide comparisons of visibility levels at different sites. In addition, photographs can serve as valuable illustrations in public information programs.
2. **Atmospheric optical monitoring** is accomplished with measurements of light extinction and the scattering and absorption components of light extinction, using transmissometers, nephelometers, and filters for light-absorbing carbon. These systems can be very expensive and difficult to maintain, but can provide useful data.
3. **Particle monitoring** should include mass, size distribution, and chemical composition. Particulate samplers should accompany camera systems in any type of trend monitoring, to determine the cause of any visibility reduction by measuring the concentration of airborne particles.

Since even a slight increase in particulates can noticeably decrease visual range, it is important to establish a visibility baseline to protect the Wilderness from future impairment by air pollution. The particle-size category most likely to cause visibility impairment is 0.1 - 2.5 microns in diameter (a micron is one millionth of a meter). These particles typically consist of sulfate, nitrate, organic carbon (soot), and soil-related species.

Particle monitoring should use the technology and monitoring, data-analysis, and quality-assurance and -control protocols of the IMPROVE ("Interagency Monitoring of Protected Visual Environments") monitoring network; electrical power is necessary for this equipment. In more remote locations, solar-powered technologies such as SMART ("Solar-powered Monitoring of Aerosols in Remote Terrains," being developed by the University of California, Davis) should be used. It is likely that many low-elevation areas can be monitored with IMPROVE technology, whereas most high-elevation sites and Wilderness Areas will require the portability and solar capability of the SMART samplers.

The Forest Service's visibility monitoring program began in 1983, and comprises approximately 50 sites. Region 2 currently maintains four active locations (two for the Weminuche Wilderness, one each for the Mt. Zirkel and Maroon Bells Wildernesses). One of the Weminuche camera sites is coupled with an IMPROVE particulate sampler, and other locations may utilize the SMART particulate samplers in the future. More visibility monitoring sites are planned in the Region.

The role of visibility monitoring in the PSD regulatory process is to answer such questions as:

1. Would visibility be affected by changes in concentration of particulates,  $SO_x$ ,  $NO_2$ ,  $NO_x$ , or organic and elemental carbons?

2. What types of particulates most commonly cause visibility impairment on the Forest?
3. What is the current visibility from the selected viewpoints? How does it change seasonally, and how does it compare to the visibility at other Regional and national locations?
4. What are the impacts from prescribed-burn and wildfire smoke?

The models and analysis techniques available to address these questions are:

<u>Model Name</u>	<u>Where Available</u>	<u>Model Function/Output</u>
PLUVUE	EPA, NPS, State of CO	Calculates effect of emissions on visual range reductions.
VISCREEN	EPA, NPS, State of CO	Screening technique used with PLUVUE.

#### **RECOMMENDED PRIORITIES FROM THE ESTES PARK SCREENING MEETING: VISIBILITY**

Trend and baseline visibility monitoring is needed in each Wilderness or area that is representative of a given Wilderness, and monitors need to be located at both high and low elevations. At high elevations, ambient concentrations tend to be lower and reflect regional contributions; at lower elevations, they are higher and indicate more local influences. Monitoring at low elevations is also necessary because layered haze, especially in winter, is trapped at low elevations, and high-elevation monitoring would not be representative. Also, the group strongly recommended that monitoring be a perpetual, ongoing activity -- it should not be started, only to be stopped later.

#### **SUPPORTING INFORMATION: ATMOSPHERIC DEPOSITION AND METEOROLOGY**

To assist in the interpretation of aquatic-ecosystems data, **atmospheric-deposition measurements** can be very useful. The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) offers data to researchers, land managers, policy makers, and others concerned with atmospheric deposition. Precipitation-chemistry data are available for all 200 sites in the national network, and include seasonal and annual summaries, temporal and spatial trends, geographic distribution of precipitation chemistry, and the display of geographical patterns of chemical deposition.

The Forest Service currently operates ten NADP stations in Colorado and Wyoming (there are 25 such sites in the two states, funded and operated by a variety of federal and state agencies and universities). Weekly precipitation is measured in Belfort Universal rain gages, whereas samples for chemical analysis are collected using Aerochem Metrics Wet/Dry precipitation samplers. Each Tuesday, the rain-gage catch and sample volumes are recorded nationwide, and the precipitation samples sent to the NADP central laboratory at the Illinois State Water Survey for analysis. The parameters measured are field pH and specific conductance, lab pH and specific conductance,  $\text{NH}_4$ , Ca, Mg, Na, K,  $\text{SO}_4$ ,  $\text{NO}_3$ , CL, and  $\text{PO}_4$  concentrations. Specific protocols are followed in site location, operation, and sample collection. Quality-assurance and -control techniques are employed in the analytical procedures and in the overall site operation, to

ensure the data is of sufficient quality to be used in the regulatory process. Data are available<sup>22</sup> on request from the NADP/NTN coordination office at Colorado State University.

The data and information from the atmospheric-deposition monitoring program can be used to address trends in deposition concentration for sulfate and nitrate; trends in precipitation chemistry; the relationships between existing and proposed air pollution emissions, atmospheric deposition and ambient-air chemistry, correlation with water-chemistry changes in monitored lakes; and impacts from fine particulate matter from prescribed-burn and wildfire smoke.

Models and analysis techniques available to estimate trends in acidic deposition are:

<u>Model Name</u>	<u>Where Available</u>	<u>Model Function/Output</u>
ARM3	State of CO, EPA	Designed specifically for use in Rocky Mountains. Predicts wet deposition based on emissions, precipitation, and meteorology.
TAPAS	FS-Rocky Mtn. Sta.	A group of models designed to analyze potential air-pollutant effects in mountainous terrain.
VALLEY	EPA	Screening model for EPA-approved model "complex 1". Used for short distances from source to receptor. A "worst case" concentration estimate for SO <sub>2</sub> .

Long-term uses of meteorological data vary, and meteorological stations often monitor only local conditions that are difficult to extrapolate to other areas. In complex terrain, diurnal up-and-down valley flows may be monitored by meteorological stations such as RAWs, but these do not reflect pollutant flows carried from major point or area sources. These data are generally better than none at all, however. Information about upper-air-flow patterns (winds aloft) is the most useful for determining pollution transport into the Region, but must be extrapolated from the winds-aloft measuring sites at Denver and Grand Junction for local areas; Denver and Grand Junction winds-aloft data are available from the State Climatologist in Ft. Collins, CO.

The potential uses of meteorological data can include using temperature, relative-humidity and solar-radiation data in lake evaporative models; using relative-humidity data for interpretation of visibility data (if a meteorological station is near the camera site); and using wind speed and direction for pollutant-transport models. Most current pollutant-transport models use data from the source, not the receptor site.

Table 1, showing existing air quality data in the Region, follows this chapter's "Footnotes" section. See Chapter 6 for a list of LACs for AQRV's and sensitive receptors that may be identified for ecosystems in a particular Wilderness area.)

# FOOTNOTES

<sup>1</sup> 36 CFR 219.12(k)(4)(ii).

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<sup>5</sup> This information parallels information needs given by Fox, D.G., J. Bernabo, and B. Hood, "Guidelines for Measuring the Physical, Chemical, and Biological Condition of Wilderness Ecosystems;" USDA Forest Service, Rocky Mtn. For. Range Exp. Sta., Ft. Collins, CO; General tech. rep. RM-146, 1987.

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<sup>7</sup> Biological Methods Panel Committee on Oceanography, Division of Earth Sciences, National Research Council, "Recommended Procedures for Measuring the Productivity of Plankton Standing Stock and Related Oceanic Properties," National Academy of Sciences, Washington, D.C., 1969.

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<sup>18</sup> Campbell, Turk, and Spahr; 1990.

<sup>19</sup> Cadle, S. M., J. Dasch, and N. Grossnickle, "Retention and Release of Chemical Species by a Northern Michigan Snowpack," *Water, Air, and Soil Pollution* 22: 303-319, 1984.

Stottlemeyer, R., "Snowpack Ion Accumulation and Loss in a Basin Draining to Lake Superior," *Can J. Fish. Aquat. Sci.* 44: 1812-1819, 1987.

<sup>20</sup> Baird, S.F., D. Buso, and J. Hornbeck, "Acid Pulses from Snowmelt at Acidic Cone Pond, New Hampshire," *Water, Air, and Soil Pollution* 34: 325-338, 1987.

Cadle, S.M., J. Dasch, and N. Grossnickle, *Ibid.*, Footnote 19.

Galloway, J., G. Hendrey, C. Schofield, N. Peters, and A. Johannes; "Processes and Causes of Lake Acidification during Spring Snowmelt in the West-Central Adirondack Mountains, New York;" *Can. J. Fish. Aquat. Sci.* 44: 1595-1602; 1987.

Phillip, S.F., D. Wotton, and D. McEachern, "Snow Chemistry in the Flin Flon Area of Manitoba," *Water, Air, and Soil Pollution* 30: 253-261, 1986.

Stottlemeyer, R., Ibid., Footnote 19.

Protocols for sample collection are available from John Turk, USGS, Mail Stop 415, PO Box 25046, Denver Federal Center, Denver, CO 80225.

- <sup>21</sup> Brown, P.J., G. Haas, and M. Manfredo; "Identifying Resource Attributes Providing Opportunities for Dispersed Recreation;" Final Report 16-631-CA, 16-661-CA; submitted to Richard S. Driscoll, USDA FS, Region 2, Denver, CO; 1977.

Brown, P.J., and G. Haas; "Relationship between the Resource Attributes and Psychological Outcomes Perceived by Wilderness Recreationists;" Trial Report 16-764-CA, 16-646-CA, 16-740-CA; submitted to Richard S. Driscoll, USDA FS, Region 2, Denver, CO; 1980.

Walsh, R. G., R. Gillman, and J. Loomis; "Wilderness Resource Economics: Recreation Use and Preservation Values [Draft];" Dept. Econ., Colo. St. Univ.; Ft. Collins, CO; 1981.

- <sup>22</sup> National Atmospheric Deposition Program, 1987.

#### APPENDIX 4-1: CRITIQUE OF ANC MODELS

(As discussed by the Aquatics Work Group at the Estes Park Screening Meeting)

##### **CARY MODEL FOR AQUATIC ECOSYSTEMS**

Data are not generally available for us to know which runoff percentage line is representative, or what the evapo-transpiration rates are. Data are rare above 9,000 feet for deposition amount and chemistry. Watershed sources of ions (e.g., sulfate) were not considered. Systems are more sensitive to damage than indicated by the model, and it doesn't specifically address episodic acidification. The sum of the base cations (Cb) may not be equal to ANC. The slopes of the red and green lines are not appropriate for the West. Western lakes fall within the yellow zone, so no guidance other than "no automatic recommendation for issuance of permits" is provided. The model excludes in-lake processes. Recommendation: Do not use as a screening tool.

##### **HENRICKSON-WRIGHT MODEL**

The *f* factor is assumed constant. Watershed inputs for sulfate were not considered. Background sulfate is assumed constant. The model uses calcium and magnesium only, no other base cations. The model was not validated with historic data (i.e., it is unverified), and it excludes in-lake processes. Recommendation: Don't use the model.

##### **MAGIC (MODEL OF ACIDIFICATION OF GROUNDWATER IN CATCHMENTS)**

The model has versions featuring either a regional or a watershed application. It excludes in-lake processes, and requires base saturation, cation exchange capacity (CEC), etc., for soils, which are currently unavailable. It doesn't handle episodic acidification, and lumps parameters by region or watershed. It conveniently runs on PC. Recommendation: Use; contact John Royce {where?} regarding application to western watersheds. Note: MAGIC was recommended by the National Atmospheric Precipitation Assessment Program (NAPAP).

##### **ILWAS (INTEGRATED LAKE-WATERSHED ACIDIFICATION STUDY)**

Thirty-seven coefficients are required to run the model, thus, there are extreme data-input requirements suitable only for research watersheds. Only Tetra Tech, Inc., can run it (or perhaps EPRI), which takes many days. Recommendation: Do not use this model.

##### **RAINS**

This model is similar to MAGIC, i.e., it has a watershed and regional basis. Recommendation: It may be considered an alternative to MAGIC.

##### **ETD (ENHANCED TRICKLE-DOWN)**

The processes (weathering etc.) may not be representative, and NAPAP does not recommend use. Recommendation: Do not use this model.

#### **EPISODE REGRESSION MODELS**

These are not calibrated for the Rocky Mountains, and require episodic data. The model is too data-intensive and could not be used alone; we would still have to use a process model. Recommendation: Use, but only for population estimates.

#### **TWO-BOX MODEL**

This requires the estimation of the ratio of old water in streams (with isotope data) to new water, as well as the use of episodic data. Recommendation: Has potential; try for test watersheds.

#### **BIRKENES**

This was developed at low-elevation sites in Norway, for waters that are high in dissolved organic carbon (DOC). Therefore, the model is not representative for our Region. Recommendation: Don't use the model.

**OTHER RECOMMENDED MODELS:** All episodic models recommended in the NAPAP State of the Science and Technology (SOS/T) reports, sec. 5.

Table 4-1

## REGION 2 EXISTING AIR-QUALITY-RELATED-VALUE AND AIR-CHEMISTRY MONITORING

FOREST	PROXIMITY	TYPE	WHEN	WHO	DESCRIPTION
Bighorn	Cloud Peak WA*	Lake Chemistry	84-ongoing	Wyoming Game & Fish	Sporadic water sampling
Bighorn	Cloud Peak WA	Lake Chemistry	85	EPA	Western Lakes Survey - 9 Lakes
Bighorn	Adjacent to Wilderness	Lake Chemistry	85	EPA	Western Lakes Survey - 2 Lakes
Bighorn	Gillete, WY	Air Chemistry	82	Hampshire Energy	TSP, SO <sub>2</sub> , Ozone, NOx monitoring
GMUG	Mexican Cut Cebolla and Taylor River Districts	Salamander	83-90	Rocky Mtn. Biological Lab	Population and deposition-effects study
GMUG	Grande Mesa at Ward Lake	Acid Precip	83-ongoing	USGS	Elevation 10,200 ft.
GMUG	Paonia, Cebolla, Taylor River Districts	Lake Chemistry	89-ongoing	District sample collection and Rocky Mtn. Exp. Station analysis	Synoptic survey - 1 grab sample per lake
GMUG	ALL Wilderness Areas	Soils		USDA Forest Service	Correlated to NCSS standards at Order 3 & 4
Med. Bow	Glacier Lakes (GLEES)	Watershed Study	88-ongoing	Rocky Mtn. Exp. Station	Integrated watershed study air, snow, water, and plant chem.
Med. Bow	Snowy Range	NADP - Wet Deposition	86-ongoing	Rocky Mtn. Exp Station	Two sites
Med. Bow	Adjacent to Wilderness	Lake Chemistry	85	EPA	Western Lakes Survey - 3 Lakes
Med. Bow	Snowy Range	Visibility	91-ongoing	FS camera	Photos 3X/day
Med. Bow	Thunder Basin N.G.	Air Chemistry	88	coal, oil & gas corporations	Total Suspended Particulate Samplers
Med. Bow	Glacier Lakes (GLEES)	NDDN - Dry Deposition		Rocky Mtn. Exp. Station	1 site
Med. Bow	Glacier Lakes (GLEES)	Air Chemistry		Rocky Mtn Exp. Station	Dichotomous Stacked Filter Units (Particulate Samples) 24 hour averages

\*WA = Wilderness Area

FOREST	PROXIMITY	TYPE	WHEN	WHO	DESCRIPTION
Med. Bow	Med. Bow NF (N. portion)	Air Chemistry		Basin Electric Power Plant Wheatland, Wyoming	SO <sub>2</sub> , NO <sub>x</sub> & Particulate Samplers
Arapahoe	Indian Peaks WA	Lake Chemistry	85	EPA	Western Lakes Survey - 2 lakes
Roosevelt	Comanche Peak WA	Lake Chemistry	85	EPA	Western Lakes Survey - 1 lakes
Roosevelt	Indian Peaks WA	Lake Chemistry	85	EPA	Western Lakes Survey - 10 lakes
Roosevelt	Adjacent to Wilderness	Lake Chemistry	85	EPA	Western Lakes Survey - 2 lakes
Routt	Mt. Zirkel WA	Lake Chemistry	85	EPA	Western Lakes Survey - 15 lakes
Routt	Storm Peak- Mt. Zirkel WA	Visibility	90-ongoing	FS camera Air Resource Specialists -Fort Collins (analysis)	Photos 3X/day
Routt	Storm Peak- Mt. Zirkel WA	Air Chemistry	90	Forest Service Instr. U.C. Davis does analysis	Portable particulate sampler service once/month w/analysis available in 6-hour increments. 2-month study
Routt	Buffalo Pass & Dry Lake- Mt. Zirkel, WA	NADP - Wet Deposition	86-ongoing	Forest collects, NADP contracts with Central Analytical Labs for analysis	Chemistry from rain and snow collected weekly
Routt	Mt. Zirkel, WA	Lake Chemistry	84-ongoing	USGS collects and analyzes	Intensive inventory-3X/Summer for each of 4 lakes (2 inside and 2 outside Wilderness Area)
Rio Grande	Weminuche WA & S. San Juan WA	Lake Chemistry	85	EPA	Western Lakes Survey: 7 lakes in wilderness, 2 lakes outside WA
Pike & San Isabel	Collegiate Peaks WA	Lake Chemistry	91	District sample collection, Rocky Mtn Expt. Station analysis	Synoptic Survey - 1 grab sample per lake
Pike & San Isabel	Manitou Exp. Forest, W. of Colorado Springs	Ozone	88 summer only	USDA Forest Service	Hourly average concentrations
Pike & San Isabel	Manitou Exp. Forest, W. of Colorado Springs	NADP - Wet Deposition	78-ongoing	USDA Forest Service	Chemistry from rain & snow collected weekly
San Juan	Molas Pass- (Weminuche WA)	Bulk Deposition	?-? ongoing	?	Chemistry of rain, snow, dryfall over unspecified durations
San Juan	Molas Pass- (Weminuche WA)	Air Chemistry	87-ongoing	Forest collects, U.C. Davis analyzes	24-hr particulate samples twice a week Part of IMPROVE network
San Juan	Molas Pass- (Weminuche WA)	Visibility	86-ongoing	Forest collects, Ft. Collins Air Resource Specialists analyze	Photos 3X/day

FOREST	PROXIMITY	TYPE	WHE	WHO	DESCRIPTION
San Juan	Molas Pass- (Weminuche WA)	NADP-Wet Deposition Lake Chemistry	86-ongoing	Forest collects, Central Analytical Labs analyzes Forest/USGS collects, USGS analyzes	Weekly chemistry from rain and snow. Intensive 3X/summer for each of 6 lakes.
San Juan	Weminuche WA	Western Lake Survey	85	EPA analyzes with Forest help in collection	Western Lake Survey for 13 lakes.
San Juan	Forestwide	Lake Chemistry	84	Forest and Ft. Lewis College	Synoptic survey of 70 lakes including geologic/parent material classif.
Shoshone	Fitzpatrick & Papo Agie WA's	NADP - Wet Deposition	84-ongoing	Forest collects, Central Analytical Labs analyzes	Weekly chemistry from rain and snow Bulk precip collected at one site
Shoshone	Fitzpatrick & Papo-Agie WAS	Lake Chemistry	84-ongoing	Forest collects, USGS analyzes	Intensive 3X/summer for each of 2 lakes
Shoshone	Wind River & Beartooth Ranges	Lake Chemistry	84	EPA w/ Forest help in collection	?
Shoshone	Fitzpatrick & Papo-Agie WAS	Phyto- & Zoo- plankton	84-ongoing	Forest collects, Provo analyzes	Sampled when lakes are sampled. Objective is population response to pH or other changes.
Shoshone	Ross Lake Drainage Fitzpatrick WA	Soil Survey	87	USFS	Reconnaissance of Soil Types and Their Distribution. One permanent Soil Transect.
Shoshone	Fitzpatrick WA	Water	85	EPA	Western Lakes Survey - 6 Lakes
Shoshone	Papo Agie WA	Water	85	EPA	Western Lakes Survey - 7 Lakes
Shoshone	Adjacent to Wilderness	Water	85	EPA	Western Lakes Survey - 7 Lakes
White River	Flat Tops WA	Lichen	82 & 92	Smithsonian contract & other contractors TBA	Inventory at 21 sites 137 species -tissue analysis as well as population response
White River	Eagles Nest & Maroon Bells WA's	Vascular Plants	88-ongoing	Eagles Nest - C.U.Boulder Maroon Bells - Univ. of WY	Inventory - T & E species and ID of plant list for those WA's
White River	Flat Tops	Phyto & Zoo Plankton	83	USGS - EPA	One-time inventory
White River	Flat Tops	Lake Chemistry	81-ongoing	USGS	Intensive 3X/summer on Ned Wilson Lake
White River	Maroon Bells, Eagles Nest, Collegiate Peaks, Flat Tops, Hunter- Frying Pan & Holy Cross WA's	Lake Chemistry	85	EPA w/ Forest help in collection	Western Lake Survey - 18 lakes in 6 Wilderness Areas

FOREST	PROXIMITY	TYPE	WHEN	WHO	DESCRIPTION
White River	Flat Tops	Lake Chemistry	82-83	EPA w/ Forest help in collection	Intensive Study for 1 Summer on 3 Lakes
White River	Maroon Bells, Collegiate, and Hunter/Frying Pan WA's	Lake Chemistry	85-90 ongoing	Aspen Wilderness Workshop and Forest collection, Rocky Mtn. Expt. Station analysis	Grab Samples on 42 Lakes Analyzed pH, Alk., and Cond.
White River	Eagles Nest	Lake Chemistry	90	CU Boulder Collected Rocky Mtn Exp. Sta. Analyzed	Synoptic Survey-Grab Samples
White River	Flat Tops	Visibility	81-83	USGS/FS/EPA	Pictures - 5 View Points
White River	Flat Tops	Soil Survey	76-80	USFS	4th order survey, publishing pending
White River	Sunlight Peak & 4-Mile Road (near Flat Tops & Maroon Bells)	NADP	88-ongoing	USFS collects NADP analyzes	2 sites
White River & GMUG	Near Flat Tops	Visibility	76-86	Cathedral Bluffs Oil Shale	15 sites for various periods

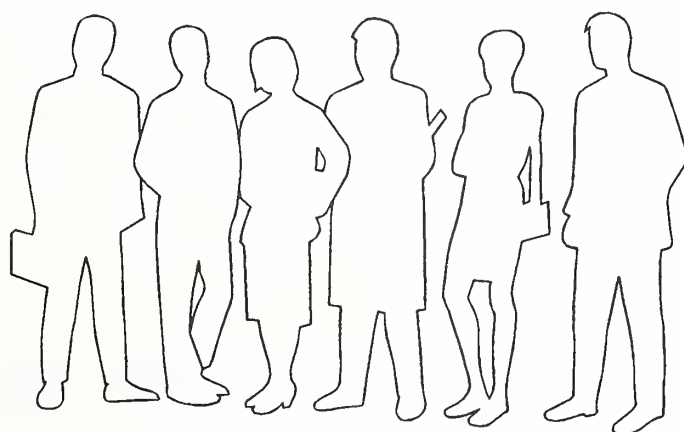
#### ADJACENT MONITORING IN NATIONAL PARKS:

LOCATION	TYPE	WHEN	WHO	DESCRIPTION
Mesa Verde NP	Visibility	78-ongoing	NPS Collects ARS-Ft Collins analyzes	Photos 3X/day - 1 view
Mesa Verde NP	Visibility	88-ongoing	NPS Collects & Analyzes	Transmissometer
Mesa Verde NP	Air Chemistry	87-ongoing	NPS Collects U.C. Davis analyzes	IMPROVE fine-particulate monitor
Mesa Verde NP	Air Chemistry	82-87	NPS Collects U.C. Davis analyzes	Dichotomous Stacked Filter Units (Particulate Monitoring)
Rocky Mtn NP	Visibility	85-ongoing	NPS Collects ARS-Ft Collins Analyzes	Photos 3X/day
Rocky Mtn NP	Visibility	87-ongoing	NPS Collects & Analyzes	Transmissometer
Rocky Mtn NP	Air Chemistry	86-87	NPS Collects U.C. Davis analyzes	Dichotomous Stacked Filter Units (Particulate Monitoring)
Rocky Mtn NP	Lake Chemistry	85	EPA	Western Lakes Survey - 23 Lakes
Rocky Mtn NP	Phyto. & Zoo. Plankton	84-ongoing	NPS	Phytoplankton since 84 Zooplankton -erratic 84-90

ADJACENT MONITORING IN NATIONAL PARKS (Cont):

LOCATION	TYPE	WHEN	WHO	DESCRIPTION
Rocky Mtn NP	Ozone	86-88	NPS	Average hourly concentrations
Yellowstone NP	Lake Chemistry	85	EPA	Western Lakes Survey - 7 Lakes
Yellowstone NP	Lake Chemistry	81	Fish & Wildlife Service	Synoptic survey
Grand Teton NP	Lake Chemistry	85	EPA	Western Lakes Survey - 2 Lakes
Dinosaur Nat. Monument	Air Chemistry	84-86	NPS Collects U.C. Davis analyzes	Dichotomous Stacked Filter Units (Particulated Sampling)
Black Canyon Nat. Monument	Visibility	85-ongoing	NPS/BLM collects	3 Photos/day
Great Sand Dunes Nat. Monument	Visibility	87-ongoing	NPS Collects	3 X per day photos and IMPROVE

TRAINING AND EXPERTISE  
NEEDED FOR AIR RESOURCE  
SPECIALISTS





## CHAPTER 5: TRAINING AND EXPERTISE NEEDED FOR AIR RESOURCE SPECIALISTS

### INTRODUCTION

The purpose of this section is to present training suggestions to Forest Service employees involved in air resource management. Consider this an all-inclusive "wish list" of working-level knowledge and developmental training that would be incorporated in the training program of anyone with full or part-time air resource management responsibilities.

Forest Service air resource managers come from a variety of educational and experience backgrounds. This is partly because the Office of Personnel Management Handbook X-118 does not currently list an occupational series (job category) for air resource management (ARM). The field is a relatively new one to the Forest Service, with the possible exception of Fire or Fuel Management Officers who prepare prescribed-burning or smoke-management plans.

Many kinds of specialists could do well in ARM. Much of the program involves familiarization with state and federal laws, as well as technical terms. The X-118 Handbook lists several professions that would probably fit well into the air resource field. Meteorologists, Hydrologists, and Soil Scientists usually have the technical background to understand the terms and values used in ARM. Other appropriate specialists are Ecologists, Environmental Protection Specialists, Plant Pathologists, Chemists, Biologists, Geologists, and Foresters.

Most Forest Service Regions have a GM-13 program manager as the lead person for ARM. In Region 2, many of the Forest air quality managers are hydrologists or other specialists, with ARM as a collateral duty. Zone positions (covering two or more adjacent Forests) would also be an excellent means of managing the air program cost-efficiently. There is a great need for more entry-level trainee positions in ARM, as this speciality becomes more important and the opportunities increase in the Forest Service.

Training options would certainly include the annual Regional air program managers' technical sessions, held in various locations. State-sponsored and other localized training sessions are great sources of current information. The National Park Service offers several courses yearly, such as "Gaseous Pollutant Monitoring," "Biological Monitoring Techniques," and "Air Resource Management." These usually have limited-availability seating for other agencies such as the Forest Service, but we do have access to them. Smoke-management courses offered by the Forest Service or BLM are also recommended.

### WORKING-LEVEL KNOWLEDGE

Air resource specialists' training needs will be defined by their workloads, experience, and education, and through consultation with their immediate supervisors. They need a working-level knowledge of the following technical subjects:

Clean Air Act, federal and state regulations, FSM and FSH sections pertaining to ARM  
Meteorology

Basic ambient-air monitoring (particulate, ozone)  
 Site selection for monitoring visibility and  $SO_2/O_3$ /P.M. in ambient air  
 Visibility measurements and data analysis  
 Atmospheric-deposition sampling and data analysis (i.e., NADP)  
 Principles and practice of air pollution control  
 PSD regulations, evaluation, and screening  
 Dispersion modeling  
 Approved EPA models  
 Topographic Air Pollution Analysis System (TAPAS)  
 Air quality related to fire and smoke management  
 Biological/vegetative responses to air pollution  
 Measured effects of air quality on AQRV's and forest resources  
 Wilderness Act and monitoring requirements/limitations  
 Air Resource Data Base Management  
 EPA New Source Review & BACT requirements  
 ARM programs in other agencies, such as NPS, BLM, Fish & Wildlife Service  
 (for coordination purposes)

Additional technical knowledge and skills useful to ARM specialists at different organizational levels are as follows:

#### GS-5 TRAINEE

TECHNICAL SKILLS	TRAINING SOURCES
1. Interpret photos, read maps, delineate airsheds.	FS, SCS, NASA courses Job Training (OJT).
2. Use and maintain weather and air-quality instruments.	USGS videotapes/personnel, OJT with Air Resource Technicians.
3. Analyze air quality in the field.	EPA, USGS, and academic courses.
4. Survey airshed conditions.	OJT, EPA, NPS, FS Regions.
5. Develop air-quality climatic data and AQRV data & calculations.	EPA videotapes, OJT with Air Resource Technicians.
6. Prepare and enter air resource data into computers.	OJT, several FS, BLM, EPA courses on data processing.

#### GS-7 ADVANCED TRAINEE

TECHNICAL SKILLS	TRAINING SOURCES
1. Operate simple air resource smoke-dispersion computer programs.	Self-study of SASEM and VISCREEN model.
2. Conduct air resource education for school children and concerned groups.	Agency instructor training or academic courses.

- |   |   |
|---|---|
| 3. Coordinate air resource/weather information with other resources. resources.         | FS courses in problem-solving, LMP, and OJT with other resources. |
| 4. Share air resource/weather/pollution knowledge with others, participate on ID teams. | Academic and governmental communications and writing courses.     |

### GS-9 AIR SPECIALIST

#### TECHNICAL SKILLS

#### TRAINING SOURCES

- |  |   |
|--|---|
| 1. Make professional judgments/recommendations to line officers for resource decision-making.  | Training in NEPA and NFMA (FS or contractor); CAA provisions (EPA)          |
| 2. Be familiar with team-building concepts and interagency relationships.  | OJT.  |
| 3. Provide basic air resource training to employees and the public.  | Advanced instructor and public-speaking trng (FS or contractor).            |
| 4. Function as a District air resource coordinator on less complex or controversial issues.  | Marketing courses (academic), training in all resource disciplines (FS)     |
| 5. Interpret weather and air-quality data for management needs, with review by higher-level ARM specialists.   | USGS, EPA, and academic technical and statistical courses; self study.      |
| 5. Measure air-pollution effects on AQRVs.   | NPS.  |
| 6. Provide input into the Land Management Planning process, air-quality-related values, protection-and-management efforts, and other activities that affect air quality. | FS training in other resources, i.e., soil, water, timber, recreation, etc. |

### GS-11 AIR SPECIALIST

#### TECHNICAL SKILLS

#### TRAINING SOURCES

- |   |  |
|---|--|
| 1. Design and implement data-collection/storage networks. Interpret data for management decisions without review. | CSU Air Quality course, EPA and FS training.   |
| 2. Testify as an expert witness on ARM-related court cases.   | Air resource hearings (state), academic air-quality-law courses, details (FS, NPS, EPA). |

- |   |   |
|---|---|
| 3. Handle all but the most complex Regional or national ARM issues or problems.                                       | OJT; FS/WO details, workshops, and meetings; meeting-management training.                 |
| 4. Function on ID teams for FLMP or project analyses. Work with other agencies, coordinate with FS Research stations. | Interpersonal-relations, advanced meeting-mgmt., team-building, and negotiations courses. |
| 5. Manage budget and work planning for the unit ARM program.  | OJT; MBO and other management courses.  |
| 6. Supervise effectively.   | Courses in supervision, motivation, and communications (FS & contractors).                |
| 7. Function within FS legal requirements and technological-support systems (DG, CEO/CLI, GIS, RAWS, remote sensing).  | Conferences, short courses, workshops.  |
| 8. Ensure prescribed-burning activities have considered air-management regulations.                                   | FS or BLM smoke-management courses.   |

#### GS-12 AIR SPECIALIST

##### TECHNICAL SKILLS

##### TRAINING SOURCES

- |  |  |
|--|--|
| 1. Synthesize conflicting technical information into coherent and sound policy; direct programs. | MBO, goal programming, management courses and workshops.   |
| 2. Initiate Regional interagency air-resource/weather programs.                                  | Management, communications, and marketing courses.         |
| 3. Translate national legislative policy into Regional or local programs and policy.             | Policy and Congressional courses; details to WO, PAO work. |
| 4. Testify as expert witness in court.   | Same as for GS-11.   |
| 5. Prepare unit's budget, work program.  | Same as for GS-11.   |
| 6. Formulate strategy to respond to appeals and lawsuits.  | Management training programs.                              |

### GM-13 AIR SPECIALIST

#### TECHNICAL SKILLS

#### TRAINING SOURCES

- |   |   |
|---|---|
| 1. Evaluate the adequacy of ARM/weather programs proposed or conducted by others. | Problem-solving and decision-making courses, management training. |
| 2. Initiate Regional or national training programs.                               | Sales and marketing courses, advanced management-concepts trng.   |
| 3. Develop Regional ARM program direction.  | Executive-development programs, i.e., Penn State, OSU, Duke, OPM. |
| 4. Utilize interdisciplinary expertise to review PSD applications.                | OJT, FS workshops on New Perspectives.                            |
| 5. Participate in State and local air-management regulation development.          | State air resource hearings, EPA courses on the Clean Air Act.    |

### DEVELOPMENTAL TRAINING FOR AIR RESOURCE SPECIALISTS

At all grade levels, individuals can benefit from cross-training in such other sciences as geology, fire, soil, water, aquatic biology, plant physiology, and light physics. Furthermore, nontechnical career-development skills such as those listed below are as important as expertise in the physical and biological sciences. These recommendations are not meant to be definitive or all-inclusive, and are offered as suggestions for the employee and supervisor to consider. Training is available through OJT, FS courses, other agencies, the Office of Personnel Management, academic institutions, correspondence courses, and consultants.

#### GS-5/7

New-employee orientation  
Oral communication  
Listening  
Letter and technical writing  
Interpersonal relations  
Instructor training  
Safe and healthy work habits  
Defensive driving  
Good HOST/stewardship

#### GS-9

Group dynamics  
Marketing  
Team leadership  
Fundamentals of management  
Budgeting  
Multi-resource cross-training/exposure  
Supervision  
Time management  
Goal setting/career planning  
Advanced public speaking

#### GS-11

Video presentations  
Expert witness

#### GS-12/13

Policy formulation/management  
Executive seminars

ID team performance  
Media relations  
Human relations  
Conflict resolution  
Public involvement  
Formal presentations  
Program development  
Career counseling  
Problem solving/decision making  
Meeting management  
Inter-agency communication  
and coordination  
Computer database skills (GIS,  
WRIDS, etc.)

Counseling/mentoring  
Negotiation in difficult situations  
Congressional/legislative operations  
Consulting with state-agency directors

#### ADDITIONAL TRAINING RECOMMENDATIONS

- \* Employees new to the Air Resource Management program should be given orientation to the culture, operating procedures, and policies of the Forest Service. Seasonal technicians should be trained in the proper techniques of sample collection and analysis by the Regional Office, to insure comparability of data bases within Regions.
- \* The Environmental Protection Agency, Bureau of Land Management, Forest Service, American Meteorological Society, and Air and Waste Management Association offer one- and two-week courses on various air resource subjects.
- \* All line officers and primary staff officers should be given the Air Resource Management training course. This one-and-a-half-day session introduces federal land managers to the laws, regulations, and responsibilities of Air Resource Management. It also explains the technical data needed for PSD permit review, adverse-impact determinations, and recommendations to a permitting authority.
- \* PSD Permit Review Training: New specialists with little experience in the review of PSD applications should take the EPA's three-day class on their responsibilities. The course assumes knowledge of the PSD program.
- \* Long-term training, consisting of one to twelve months of formal university course work or detail work assignments, is another option. The WO has established a graduate-level Cooperative Education program in Air Resource Management at Colorado State University, to help Regions attract individuals with skills in this profession. All relevant employment restrictions apply.

Appendix 5-1

AIR RESOURCE INFORMATION SOURCES

MAY, 1992

Note: Feel free to contact these information sources directly; however, please keep the AQ specialists in the Regional Office (and/or Supervisor's Office, if you are on a District) informed about any changes in strategy, monitoring, etc.

ACTIVITY	INFORMATION SOURCE	REMARKS
USGS Water Chemistry	John Turk USGS, Water Resources Div. Mail Stop 415, PO Box 25046 Denver, CO 80225 (303) 236-4886	
NADP - Wet Deposition	Jim Gibson NADP Coordinator NREL Colorado State University Fort Collins, CO 80523 (303) 491-5580	Cindy Olson - Site Info (303) 491-1989  Scott Dossert - Tech Support (217) 333-0249
Meteorology	Kelly Redmond Regional Climatologist Western Regional Climate Center  PO Box 60220 Reno, NV 89506-0220 (702) 677-3139	Data summaries for RAWS sites and winds aloft
Camera Sites	Kristi Savig Air Resource Specialists 1901 Sharp Point Drive, Suite E Fort Collins, CO 80525 (303) 484-7941	ARS is the national contractor for camera sites
Particulate Sampler (Portable)	Tom Cahill Crocker Nuclear Lab University of Calif., Davis Davis, CA 95616-8569 (916) 752-1124	

ACTIVITY	INFORMATION SOURCE	REMARKS
Amphibians	Steve Corn US Fish & Wildlife Service National Ecology Research Center 1300 Blue Spruce Dr. Fort Collins, CO 80524 (303) 498-5464	
Global Climate Change	Doug Fox Global Change Program Mgr. Rocky Mtn. Forest & Range Experiment Station 240 W. Prospect Fort Collins, CO 80526 (303) 498-1231	
Program Management Region 2 (RO)	Dennis Haddow (303) 236-9562  Tamara Franklin (303) 236-9561  PO Box 25127 Lakewood, CO 80225	R-2 Air Program Mgr.   R-2 Air Resource Spec.
Program Management (WO)	Donna Lamb National Air Program Director USDA Forest Service Auditors Building 201 14th St. S.W. Washington, DC 20250 (202) 205-1480  Rich Fisher National Air Program Specialist 240 W. Prospect Fort Collins, CO 80525 (303) 498-1232	
NPS Water Chemistry	Jill Baron NPS, Water Resources Div. 301 S. Howe St. #335 Fort Collins, CO 80521 (303) 491-1968	

ACTIVITY	INFORMATION SOURCE	REMARKS
PSD Permits in Colorado	<p>Jim Geier (303) 331-8582</p> <p>Dan Ely (303) 331-8529</p> <p>State of Colorado Air Pollution Control Div. 4210 E. 11th Ave. Denver, CO 80220</p>	<p>Emissions Source Info</p> <p>Monitoring, AQRV's</p>
PSD Permits in Wyoming	<p>Bernie Daly Wyoming Department of Environmental Quality Air Quality Division 122 W. 25th St. Cheyenne, WY 82002 (307) 777-7391</p>	
PSD Permits in Kansas	<p>Kansas Department of Health and Environment Forbes Field Topeka, KS 66620 (913) 296-1500</p>	
PSD Permits in Nebraska	<p>Department of Environmental Control 301 Centennial Mall South Lincoln, NE 68509 (402) 471-2186</p>	
PSD Permits in South Dakota	<p>Department of Water and Natural Resources Office of Air Quality and Solid Waste Joe Foss Building Pierre, SD 57501 (605) 773-3153</p>	

(For Personal Notes)

ACTIVITY	INFORMATION SOURCE	REMARKS

LIMITS OF ACCEPTABLE CHANGE  
FOR SENSITIVE RECEPTORS





## CHAPTER 6: LIMITS OF ACCEPTABLE CHANGE FOR SENSITIVE RECEPTORS

### INTRODUCTION

The purpose of this chapter is to describe how limits of acceptable change (LAC's) are used in air resource management in Region 2, and to present draft LAC numbers that were recommended by the working groups at the 1990 Estes Park Screening Meeting.

In the context of air resource management in Wilderness Areas, LAC's are those alterations of the physical, chemical, biological, and/or social condition of a Wilderness component that can occur without a loss of its Wilderness character. Basically, LAC's are the criteria the Forest Service uses to determine whether monitored or predicted air-pollution-caused changes are acceptable.

The identification of limits of acceptable change is a management decision based on:

1. Management goals and objectives identified in the 1964 Wilderness Act and subsequent regulations;
2. Agency, Regional, and Forest management goals and objectives identified in the Forest Service Manual, Regional Guides and Forest Plans;
3. The regulatory processes identified in Federal and State Prevention of Significant Deterioration (PSD) regulations;
4. The existing condition and sensitivity of specific wilderness components;
5. The existing or potential "state of science" related to understanding, monitoring and predicting air pollution caused changes; and
6. Public input.

Items 1 through 3 have been described in Chapter 2, "Opportunities and Responsibilities for Protecting National Forests from Air Pollution."

The sensitivity of a wilderness component depends on its vulnerability to human-caused change; inertia (ability to resist displacement from its natural condition), elasticity (ability to recover from an individual human-caused event), and resilience (the number of times it can return to its natural condition after human-caused impact). The determination of individual wilderness components' inertia, elasticity, and resiliency is not one of our tasks in Region 2; these decisions will be left to the research community. Where little information exists on these three factors, the limit of acceptable change must be set conservatively. As additional information becomes available, the LAC can be modified.

Baseline measurements are essential in order to have an idea of the characteristics and variability of each sensitive receptor, so that we will know what values to measure or project pollution-induced change against. Only when we already have established a baseline will we know when the LAC's have been met or

exceeded. The LAC's identified below are unnatural changes from the baseline condition. This presents two important needs: (1) baseline data from the potentially threatened Wilderness Area, and (2) understanding of the variation in that baseline that is a result of natural (non-human induced) environmental changes. Baseline levels are sometimes determined in the initial monitoring effort, but need not be limited to this. Indeed, the current condition may be inappropriate if pollution levels are already high, yet this information will also be useful in the review process. Baselines can also be determined from archived collections, previous studies, or from determinations in similar but more pristine environments elsewhere. Lack of baseline measurements precludes any implementation of the LAC's.

In December, 1990, a meeting of scientists, land managers, and interested members of the public was held in Estes Park, CO. One of its purposes was to recommend Limits of Acceptable Change for visibility, aquatic ecosystems, and terrestrial ecosystems based mainly on points 4, 5, and 6 listed above. The acidic-deposition LAC guidelines recommended by the working groups for each of the three categories are listed below. These recommendations are presented in draft format as the Rocky Mountain Experiment Station is currently in the process of editing them into a General Technical Report. It will be up to the land manager to integrate the recommendations that came out of this work group with the regulations, management goals, and objectives as listed in 1-3 of the Introduction to this chapter. These LAC's are included in this document to give the reader an idea of the concerns and values the Region will be considering over the next couple of years.

### VISIBILITY

A Regionwide Limit of Acceptable Change for visibility has been identified as a 5% change in contrast on any day during the visitor-use season. The Visibility Work Group at the Estes Park meetings recommended that the LAC refer to both the current-visibility and the pristine baseline. The rationale for this is that the air resource should never be allowed to deteriorate beyond current conditions, and future conditions should continually move toward natural visibility.

Other recommendations from the group included:

1. The Forest Service needs to support the development, documentation, refinement, evaluation, and application of screening and sophisticated deterministic and receptor models for uniform and layered haze resulting from multiple sources of particles,  $SO_2$ ,  $NO_x$ , and VOC's. This is especially true for the valleys and basins typical of the Rocky Mountain Region.
2. Significant or adverse visibility impairment due to plumes, layered haze, or uniform haze should be defined as one "just noticeable change" (JNC) from the pristine, if it occurs more than one hour per year. The measurement of JNC will be refined over time with recommended perception research. For now, however, changes in contrast, light-extinction coefficient, or visual range greater than 5% should be judged adverse or significant.

## AQUATIC ECOSYSTEMS (Lakes and Streams)

The only Regionwide Limit of Acceptable Change previously identified for aquatic ecosystems is a 20% change in lake alkalinity. The Aquatics Work Group at the Estes Park screening meetings recommended the following for consideration as LAC's:

### 1. Aquatic Biota

The recommended LAC is that impacts to Wilderness aquatic ecosystems that cause a reduction in endemic breeding populations of sensitive invertebrate or vertebrate taxa are not acceptable. Sensitive indicator species include benthic invertebrates, amphibians, fish, zooplankton, and diatoms.

### 2. Acid-neutralizing capacity (ANC)

The recommended LAC for lake and stream chemistry is a function of the ANC of the water. If ANC >100 ueq/l during the ice-free season, there is less concern about the potential for acidification. In that case, a 10% change is the recommended LAC. The rationale for choosing a 10% allowable change in ANC is that a change of 10% in ANC will not permit significant changes in any water chemistry variable (e.g., pH, AL+n) that would affect biological populations. Note that these LAC's represent the cumulative effect of all sources, not the effect of one PSD application under consideration.

If ANC = 25-100 ueq/l, then episodic acidification is a concern. The FLM (Federal Land Manager) needs to protect lakes and streams from episodes, and possibly for chronic acidification as well. Use 10% change as an LAC unless data show no impact at 10%. Note that the recommended LAC is the same as for greater ANC, but the recommendation is a percentage which automatically becomes more restrictive as ANC decreases. Also, with ANC between 25-100 ueq/l, the FLM needs to give specific consideration to episodic acidification and should have information available on the effect of snowmelt on ANC. The rationale for choosing a 10% allowable change in ANC is that a change of 10% in ANC will not lead to significant changes in any water-chemistry variable (e.g., pH, AL+n) that would affect biological populations. Note that these LAC's represent the cumulative effect of all sources, not the effect of one PSD application under consideration.

If ANC < 25 ueq/l, then ANC can be considered at critical levels, and this value should be considered a "red flag", whereby there is a high probability of episodic acidification. In this case, the LAC is no additional acidic inputs.

### 3. Nitrate Guidelines to Limits of Acceptable Change

A predicted late-summer or fall water sample from the epilimnion of > 1 ueq/l NO<sub>3</sub>- or total-dissolved-nitrogen indicates ecosystem damage. This concentration is a "redline" value indicating a high probability that detrimental impacts will occur at this level. No LAC was stipulated.

#### 4. Ammonia Guidelines to Limits of Acceptable Change

The concern for ammonium ion is due to emissions from fertilizer plants or oil-shale retorting that could be permitted under PSD. The presence of  $\text{NH}_4^+$  in pristine water may indicate an anthropogenic input. The recommended LAC for  $\text{NH}_4^+$  is 2  $\mu\text{eq/l}$ .

#### 5. Nutrient Enrichment and Dissolved Oxygen

Nutrient enrichment can cause algal growth that consumes available oxygen. If oxygen depletion occurs under ice cover it can result in fish kills. 3.0 ppm is recommended as a "redline" dissolved-oxygen concentration where no part of the lake has > 3.0 ppm dissolved oxygen (DO). Some participants thought that an LAC for dissolved oxygen is too indirect an effect, and therefore indefensible. The Limit of Acceptable Change is that the limiting nutrient shall not cause D.O. < 5.0 ppm under ice cover for 2/3 of the lake. Where DO is already < 5.0 in 1/3 or more of the lake (thereby leaving an inadequate refugia for fish) the LAC = 10% ppm change.

#### 6. Mercury Guidelines to Limits of Acceptable Change

It was noted by the Work Group that 0.5 mg Hg/kg in fish tissue would be adverse, however a LAC specific to mercury was not recommended by the group.

#### 7. Precipitation chemistry, snowpack ecosystem, and vernal pools

The recommended LAC is to maintain a pH > 6.0 for systems in which the pH is greater than 6.0; otherwise, a less-than-10% increase in hydrogen ion activity is the LAC.

The rationale is that this pH level is needed to protect amphibians based on present knowledge of tolerance levels. Also, macroinvertebrates and trout (Snake River trout, cutthroat trout) need a surface water pH LAC = 6.0 to protect all life stages.

If natural conditions sustain a pH < 6.0, then a doubling in  $[\text{H}^+]$  within the snowpack can be considered as a "redline", indicating conditions are definitely not acceptable and the permit should not be issued as proposed. A pH of 5.6 is the LC50 (lethal concentration for 50% of the individuals) for salamanders. The (LC50) is not the LAC, but data for consideration.

#### 8. Aluminum Guidelines to Limits of Acceptable Change

The LAC is 50 ppb total dissolved Al in the snowpack, lakes, streams, and vernal pools. This LAC should also protect groundwater and wet caves.

#### 9. Air Toxic Compounds Guidelines to Limits of Acceptable Change

We can probably use human health standards to set an LAC for air toxics, with two exceptions: a) copper, which is toxic to phytoplankton, so that the health standard would not be protective enough; and b) hormonal analogues, because the effects on amphibians would be at lower exposure than human health standards.

## TERRESTRIAL ECOSYSTEMS

No Regionwide Limit of Acceptable Change for terrestrial ecosystems has previously been identified. The terrestrial work group at the Estes Park meetings recommended the following LAC's:

POLLUTANT	RECEPTOR	AQRV	LAC (% CHANGE FROM BASELINE)	CONCENTRATION LIMIT
SO2	Lichens: especially foliose-fruticose forms and epiphytes.	loss of species .....	0%	(ug/m3) annual 13-30 chronic 15
		species composition change .....	0%	
		Mosses	loss of species .....	0%
	Vascular plants (fast-growing and riparian species will be the most sensitive, due to high stomatal conductance)	species change .....	0%	
		photosynthesis.....	<10%	decr. (LIT) *
		- Conifers: foliar lesions .....	<5%	15
		leaf tissue S .....	<10%	incr.
	- Deciduous: foliar injury .....		<5%	
		leaf tissue S .....	<30%	incr.
	Insects: especially pollenators	species composition .....	0%	
		fucundity .....	0%	
		tissue content .....	0%	
OZONE	Vascular plants (fast-growing species, riparian species will be the most sensitive, due to high stomatal conductance)	species composition.....	0%	
		phenology .....	0%	
		tissue respiration .....	<10%	incr.
		photosynthesis .....	<10%	decr.
	- Conifers: foliar lesions .....		<5%	
		seedling mortality .....	0%	
		leaf retention .....	<10%	decr.
		foliated shoot length .....	<10%	decr.

POLLUTANT	RECEPTOR	AQRV	LAC (% CHANGE FROM BASELINE)	CONCENTRATION LIMIT
OZONE	(cont.)	- Deciduous: foliar injury .....		<5%

SO<sub>4</sub>, NO<sub>x</sub>

#### Vascular plants

##### - Conifers and Deciduous:

increased growth (radial,  
or shoot) ..... ±5%  
species cover ..... ±5%  
species composition ..... ±5%  
tissue nutrient ratios:  
(trees on poor soils (e.g.  
Dystic Cryochrepts) are most  
sensitive)  
N/P ..... LIT  
(low N/P will be most sensitive)  
C/N ..... LIT  
(high C/N will be most sensitive)  
bud break or set ..... ± 0 days  
seedling mortality ..... 0%  
leaf tissue S ..... <10% incr.

##### Soils:

base saturation (should be  
about 20 meq/l) ..... low elev.. <15% decr.  
high elev.. 0%  
pH ..... ±.5 unit  
deposition (NO<sub>x</sub>) ..... <5kg/ha/yr  
SO<sub>4</sub> in soils solution ..... <50% incr.  
extractable aluminum ..... (LIT)

SO<sub>4</sub>, NO<sub>x</sub>, Soil Flora and Fauna:  
cont.

decomposition rate ..... (LIT)  
earthworm abundance ..... 0%

##### Cultural Resources:

petroglyphs (esp. on basic  
rock) ..... 0% bsln

##### Lichens:

see above for SO<sub>2</sub>

POLLUTANT	RECEPTOR	AQRV	LAC (% CHANGE FROM BASELINE)	CONCENTRATION LIMIT
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**Lichens:**

Pb 200 ppm <10% incr.

**Mosses:**

**Soils:** sensitive soils will be those with low base saturation (Dystric Cryochrepts, pergelic subgroups, and many Histosols)

organic soils (peat) .....<10% incr. AND

inorganic soils ..... 0%

concentration limits not to be exceeded:

Cu 100 ppm

Zn 400 ppm

Pb 200

Cd 1

Hg 2

Se 1

As 1

F1 3

Soil Fungi: same as for  $SO_4$  and  $NO_x$ .

Metals and  
VOC's, cont.

vascular plants: cushion plants in exposed areas of the alpine may be most likely to accumulate, due to year-round exposure.

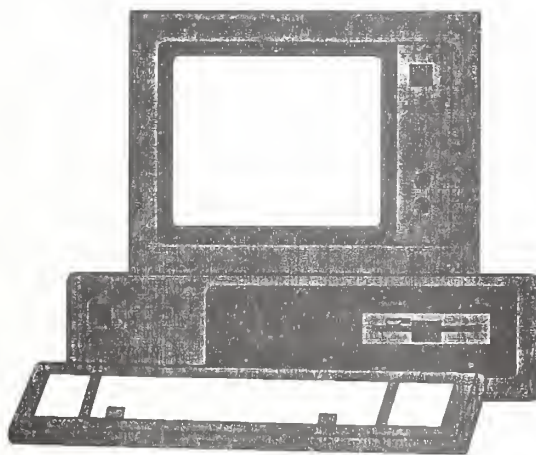
Hg, Pb, Se, As..... 0%

Cu, Zn, Cd ..... <10% incr.

POLLUTANT	RECEPTOR	AQRV	LAC (% CHANGE FROM BASELINE)	CONCENTRATION LIMIT
	<i>Bees:</i>	domestic bees may be surrogate. brood size .....<10% tissue concentration .....0-10% loss of queen ..... 0%		
	<i>Bats:</i>	guano concentration ..... LIT tissue concentration ..... LIT		
	<i>Birds:</i>	tissue concentration ..... LIT nesting success ..... LIT		
	<i>Mammals:</i>	tissue concentration ..... LIT reproductive success ..... LIT		
<i>Floride</i>	<i>All components:</i>	tissue or water concentration .. 0%		
<i>CO2</i>	<i>Vascular plants:</i>	plants that are not nutrient- limited will be most likely affected; plants with C3 metabolism will be more sensitive than those with C4 or CAM.		

\* "LIT" indicates that a literature search must be initiated to determine exact recommended values for the specific receptor.

# DATA MANAGEMENT, ANALYSIS & REPORTING





## CHAPTER 7: DATA MANAGEMENT, ANALYSIS & REPORTING

### INTRODUCTION

The purpose of this section is to outline the types of data collected in air resource management activities in Region 2, and gives specifics on their availability. The chapter also gives some background on the types of data base management systems currently used in Region 2 for air-quality-related information.

Monitoring programs are designed to produce information for use in the regulatory process. Consequently, data storage and analysis are extremely important. High-quality data are of little use, however, without analysis to extract meaningful information. The intent of the monitoring program is to establish a characteristic baseline, then use statistical analysis and models to evaluate the current and predicted effects of atmospheric deposition, as estimated from the information in a new-source permit application.

The lead agency for a specific monitoring project will be responsible for data entry and analysis. For example, NADP precipitation samples are collected by Forest Service personnel, but information management is handled by the NADP. Any analysis or modeling (in addition to the regular reporting of the lead agency) needed for land management or PSD-permit purposes will be the responsibility of the Forest or the Regional Office. To facilitate the availability of data for use in the regulatory process, all data from contracted monitoring activities must be made available to the Forest Service in an electronic format, and be updated as monitoring projects proceed.

The Forest Service Region 2 Office in Lakewood, Colorado has an air quality data base management system utilizing PC-based SAS software. This system includes Western Lake Survey data and NADP data for Colorado and Wyoming, and USGS lake-chemistry monitoring data for the Flat Tops, Weminuche, and Mt Zirkel Wildernesses. Its advantages are that it has a flexible format for the input of existing or future data, is available on PC, is menu-driven, and contains a large amount of "meta-data" (information about data, such as where, when, how, and by whom it is collected) with each data set. The disadvantages of this system are its limited graphics capability and the expense of maintenance and licensing, so that location of the DBMS will probably be limited to the Regional Office.

The Bureau of Land Management has an air quality data base management system under development called Wildland Resource Inventory Database System (WRIDS). It is being developed in modules, with the Hydrology, Emissions, and Air Chemistry sections currently completed, and the Visibility module in progress. This PC-based software is available free from BLM, is menu-driven, and can present data in graphics format. Its disadvantages include rigidity of format and type of data to be included, and difficulty importing large existing data sets into the system (they must be transformed to the Fox-base format).

A national air quality data base management system (AIMS II) was started by the Rocky Mountain Experiment Station, using Paradox software on the PC; this system was not completed, however, and the national scope of the project was dropped due to lack of funding commitments. A vegetation module was completed on the

project, and this may be of use as a template for other modules if the effort is ever resumed. This system was designed for eventual transport to DG-ORACLE software; its advantages and disadvantages have not been determined.

Data collected in conjunction with any air quality monitoring plan should be archived and kept up to date with at least one of the above systems. Also, the quality and general methodology of current or past monitoring projects must be carefully documented within the data base, to avoid inappropriate comparisons of data.

Information management also includes the storage and retrieval of biotic components (i.e., lichen-tissue samples), air-chemistry samples (filters from particulate samplers), photographs, and any other items that should be saved for future reference or analysis. A strategy for proper storage and long-term preservation of these materials should be developed.

Following are the different types of data that are being collected within the Region, cooperating agencies and contractors, the data format, and results/consequences:

#### ATMOSPHERIC DEPOSITION

National Atmospheric Deposition Program/National Trends Network (NADP/NTN)

Jim Gibson/ Carol Simmons  
NADP/NTN Coordination Office  
Natural Resource Ecology Laboratory  
Colorado State University  
Fort Collins, CO 80523  
303-491-5580 or 491-1989

Data Format: Data is sent quarterly on diskettes from the contractor to participating Forests. A semi-annual data report and annual data summary are sent to the Region 2 Office and all Forests conducting NADP monitoring.

Results/Consequences: Although the annual report graphically portrays the deposition chemistry data for each station, it does not address the data's long-term trend analysis. The maps in the annual summary are for the entire continental United States, whereas a Regional map of the data would be most useful locally. The responsibility for determining trends at each site and between sites is left to the individual Forests.

#### VISIBILITY

Kristi Savig, Air Resource Specialists, Inc.  
1901 Sharp Point Dr., Suite E  
Fort Collins, Colorado 80525  
DG address: S28A  
303-484-7941

William Malm, IMPROVE Network  
National Park Service Air Quality Division  
CIRA - Foothills Campus Colorado State University  
Fort Collins, CO

**Data Format:** Representative photographs of the best, worst, and average visibility are sent quarterly from the contractor to the Regional Office and to Forests with camera sites. Quarterly reports of all Forest Service camera sites nationwide are sent to the Regional Office.

**Results/Consequences:** The frequency that the visibility was better than or worse than average is listed for each site. A terrain/sky contrast number is also given which relates to the Standard Visual Range (SRV). Median and 90th percentile SVR's are calculated in relation to the target distance in the photos. The SVR frequency and related statistics are reported to the Inter-agency Monitoring of Protected Visual Environments (IMPROVE) program, which develops a baseline in selected Class I areas.

#### PARTICULATE SAMPLING

Tom Cahill, Bob Eldred, Ken Bower, Air Quality Group  
Crocker Nuclear Laboratory  
University of California, Davis  
Davis, CA  
916-752-1123 or 752-1124

**Data Format:** Data have been sent from the contractor sporadically and usually about a year or more after data collection. The report format is in hard copy or nine-track tape, and compares data from all IMPROVE sites nationwide. Data from these sites should be available semi-annually. The State of Colorado, Air Quality Division, will soon have it on diskette in DBASE or ASCII for all Colorado sites. Data from the portable particulate samplers (SMART samplers) will be available on a demand basis only (collected samples are archived until analysis is requested).

**Results/consequences:** Every 30 days, filters in the IMPROVE Modular Aerosol Monitoring Sampler are analyzed for coarse particle (14 - 2.5um) mass, fine particles (<2.5um) mass, optical absorption, elemental concentrations, nitrate, sulfate, and organic and elemental carbon.

#### SURFACE WATERS - LAKE CHEMISTRIES

John Turk, Project Chief  
USGS, Water Resources Division  
Bldg. 53, Mail Stop 415  
Denver Federal Center  
Lakewood, CO 80225  
303-236-4886

**Data Format:** For these three Region 2 long-term lake studies conducted by the USGS (in the Weminuche, Mt Zirkel and Flat Tops Wilderness Areas), all data are entered in the USGS WATSTORE data base. Annually, the project chief also submits data to the Oak Ridge National Lab, for the Long-Term Surface Water Monitoring Program. Scientific and professional papers summarizing the results of this monitoring are usually sent to the Regional Office by the USGS. Raw data collected from this monitoring effort is available in ASCII format from the USGS data-base administrators, upon request.

*Results/Consequences:* The focus is on defining the chemistry of selected high-elevation sensitive lakes in the Mt. Zirkel, Flat Tops, and Weninuche Wilderness Areas. The USGS conducts all data analysis on trends and watershed characterizations of these lakes.

#### AQUATIC BIOTA: PLANKTON & MACROINVERTEBRATES

Fred Mangum  
Aquatic Ecosystem Analysis Lab  
105 Page School  
Brigham Young University  
Provo, UT 84602  
801-378-4928

*Data Format:* Annual Reports summarizing zooplankton species and macroinvertebrate species found in the sample collection are sent to the District (Lander) on which they are collected. The data are currently not available in electronic format, however transfer of the data to PC at the BYU lab is expected sometime in 1992, after this time data should be available upon request in ASCII format.

*Results/Consequences:* Identify baseline conditions to determine species composition and relative abundance. Research has indicated that macroinvertebrates and zooplankton can serve as indicators of lake and stream acidification. Because these are the primary producers in the aquatic food chain, disruptions in these communities may result in changes in the upper trophic levels as well.

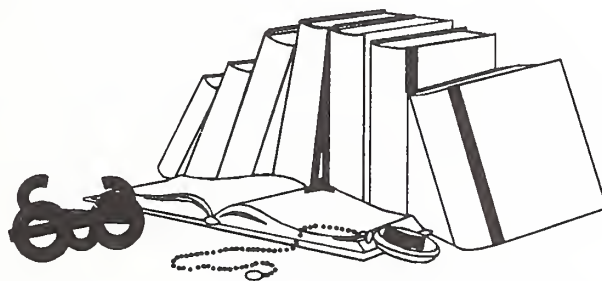
#### TERRESTRIAL BIOTA: LICHENS

Contract or University study  
(contact person will vary)

*Data Format:* Lichen studies are usually done as an initial inventory followed by follow-up monitoring done 5-10 years after the initial study. Because of this intermittent monitoring; the contractor for each study may vary, and the reporting style may also vary. At the least, the Forest and the Regional Office should receive a report at the end of each lichen monitoring field season from the contractor, and data should be made available in electronic format wherever possible.

*Results/consequences:* Lichens are sensitive to air pollution and can be identified as a sensitive receptor to atmospheric deposition. Many physiological and structural factors contribute to this susceptibility: they have a high retention capacity, and therefore accumulate elements; they have no protective cuticle to serve as a barrier to material from the atmosphere; they absorb most of their nutrients and water directly from the atmosphere; and they are long-lived. Where lichen tissue analysis is conducted, the tissue samples should be archived, in case further analysis is required at a later date.

# AIR RESOURCE MANAGEMENT GLOSSARY





## CHAPTER 8: AIR RESOURCE MANAGEMENT GLOSSARY

**ACID DEPOSITION (ATMOSPHERIC DEPOSITION):** The wet or dry transfer of pollution from the atmosphere to the surface, by any form of precipitation, gravitation, impaction, absorption, or adsorption.

**ACIDITY:** A measure of the amount of hydrogen ions ( $H^+$ ) in a solution. A solution below pH 7 is considered acidic.

**ACID RAIN:** A commonly used term for the wet component of acidic deposition. It originates in combustion (in power plants, factories, motor vehicles, etc.) that produces sulphur dioxide and nitrogen oxide emissions. These substances mix with oxygen and water vapor in the air to form acids; this acidic water vapor falls to the ground and is known as "acid rain."

**AIR POLLUTION (POLLUTANT):** Dust, fumes, mist, smoke, other particulate matter, vapor, gas, odorous substances, or a combination of these, present in the outdoors to such an extent that they are (or are likely to be) injurious to humans, animals, plant life, or property, or interfere with the enjoyment of life or property. (Note that air pollution can occur indoors, but EPA's authority under the Clean Air Act only extends to the outdoor atmosphere.)

**AIR-QUALITY-RELATED VALUES (AQRV's):** Those features or properties of a Wilderness that are (or have potential to be) changed by air pollution. Most Wildernesses have common AQRV's: flora, fauna, soil, water, cultural resources, odor, and visibility (see Table 1). In a few cases, special AQRV's are mentioned in the designating legislation. In most instances, however, individual Wildernesses were designated so that each of their values would be "protected and managed...to preserve its natural conditions".

**AIRSHED:** A term denoting a geographical area which, because of topography, meteorology, and climate, shares the same air mass. For the purposes of this document, political/civil boundaries (Forests, Wilderness Areas, counties) were also used to a lesser extent where physical boundaries were not apparent (see page 25 for further explanation).

**ALKALINITY:** A measure of the power of a solution to neutralize hydrogen ions ( $H^+$ ) usually expressed as mg/l  $CaCO_3$ . The more alkaline a body of water is, the greater its ability to buffer incoming acidity. A solution above pH 7 is considered alkaline.

**AMBIENT AIR:** The outside air encompassing a particular region.

**AREA SOURCE:** A source category of air pollution that generally extends over a large area. Prescribed burning, field burning, home heating, and open burning are examples of area sources. An area source can also be any accumulation of small air pollutant sources.

**BASELINE CONCENTRATION:** A baseline concentration of air chemistry against which to measure air-pollution increases. EPA defines two criteria to use in determining baseline concentrations of air chemistry:

(1) The ambient concentration level which existed in the baseline area as of the baseline date, minus any contribution from major stationary sources and major modifications on which construction commenced on or after January 6, 1975. A baseline concentration is determined for each pollutant for which a baseline date is established, and shall include (a) the actual emissions of sources in existence on the applicable baseline date, except as provided below; (b) the allowable emissions of major stationary sources which commenced construction before January 6, 1975, but were not in operation by the applicable baseline date.

(2) The following will not be included in the baseline concentration and will affect the applicable maximum allowable increase: (a) actual emissions from any major stationary source on which construction commenced after January 6, 1975; and (b) actual emission increases and decreases from any stationary source occurring after the baseline date. (This definition applies only to PSD permitting activities.)

**BASELINE CONDITION:** The status of a resource value at the time it was first measured, or at some previous time if the status can be determined in some other way.

**BUFFERED SOLUTIONS:** A solution is said to be buffered if its pH is not greatly changed by the addition of moderate quantities of acid or base. Most natural waters are buffered to some extent by reactions which involve dissolved types of carbon dioxide. The most effective buffering action is within the pH range of most natural waters, from near 6.0 to about 8.5.

**CLASS I AREA:** Any area designated for the most stringent degree of protection from future degradation of air quality. The Clean Air Act designates as mandatory Class I areas each National Park over 6,000 acres and each Wilderness over 5,000 acres in existence as of August 7, 1977.

**CLASS II AREA:** Any area cleaner than Federal air-quality standards which is designated for a moderate degree of protection from future air quality degradation. Moderate increases in new pollution may be permitted in a Class II area. All Wilderness areas designated after August 7, 1977, are automatically Class II Areas.

**CLEAN AIR ACT:** A federal law enacted to insure that air quality standards are attained and maintained. Initially passed by Congress in 1963, it has been amended several times, with the majority of changes in August, 1977, and November, 1990.

**FEDERAL LAND MANAGER (FLM):** "With respect to any lands in the United States, the Secretary of the Department with authority over such lands," or his/her delegated representative. [Clean Air Act, Section 102(i)]. In the Forest Service, the FLM role has been delegated to the Regional Forester.

**INCREMENTS:** Allowable increases in ambient concentrations of sulfur dioxide and particulates from new or existing sources. The amount of allowable increase is dependent on whether the area is designated Class I, Class II, or Class III for PSD.

**LIMITS OF ACCEPTABLE CHANGE (LAC'S):** Those amounts of human-caused change from the natural condition of the physical, chemical, biological, and/or social condition of a sensitive receptor that can occur without loss of Wilderness character. The identification of LAC's is a management decision; for example, in the Weminuche Wilderness, the LAC for the view from Sun Light Peak to South River Peak may be a 5% change in contrast, or the LAC in the water chemistry in Upper Grizzly Lake may be a 20% change in alkalinity. Table 1 lists potential human-caused changes in air-quality-related values.

**MACROINVERTEBRATE:** An animal without a backbone, large enough to be seen without magnification.

**METEOROLOGICAL FACTORS OR ELEMENTS:** Types of measurements necessary for the consideration of air-pollution problems. Generally, these are the pressure, temperature, and humidity of the atmosphere; the speed and direction of the wind at plume height; and, in some cases, the amount of insulation (the intensity of the sun or cloud cover and cloud type and height). Sometimes the vertical-temperature structure is essential.

**METEOROLOGY:** The science that deals with the atmosphere and its phenomena -- especially windspeed and direction, air temperature, relative humidity, long- and short-wave solar radiation, precipitation quantity, and barometric pressure data.

**NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS):** A legal limit on the level of atmospheric contamination needed for protection against adverse effects on public health and welfare, with an adequate safety margin. Primary standards are those related to health effects; secondary standards are designed to protect the public welfare from effects such as visibility reduction, soiling, material damage, and nuisances.

**NITROGEN OXIDES (NO<sub>x</sub>):** Gases formed from atmospheric nitrogen and oxygen when combustion takes place under conditions of high temperature and pressure. Nitrogen Oxides are primary air pollutants which can be harmful in themselves, as well as act as precursors of photochemical oxidants (particularly ozone) and acidic deposition. NO<sub>x</sub> often has a reddish-brown color.

**OZONE:** A pungent, colorless, toxic gas that contributes to photochemical smog. No sources directly produce ozone; it is created when nitrogen oxides, hydrocarbons, and volatile organic compounds (VOC's) mix and are exposed to sunlight.

**PARTICULATE MATTER:** Any liquid or solid particles. "Total suspended particulates" as used in air quality management are those particles suspended in or falling through the atmosphere. Generally they range in size from 0.1 to 100 microns.

**pH:** An index showing the acidity or alkalinity of a sample. pH 7.0 is neutral, <7.0 is acidic, and >7.0 is alkaline. The scale is logarithmic (i.e., each change of 1.0 represents a tenfold increase), so pH 4.0 is ten times more acidic than pH 5.0.

**PHOTOCHEMICAL POLLUTANT:** Any pollutant produced by photochemical reactions. The most common photochemical pollution involves the ultraviolet portion of sunlight, nitrogen dioxide, and certain hydrocarbons. A wide variety of new products are produced, including ozone, and these in turn react to produce other products, many of which are harmful to plants and animals.

**PM-10:** Particles with a diameter smaller than or equal to ten micrometers.

**PRESCRIBED BURNING:** The controlled application of fire to wild-land fuels in either their natural or modified state, under conditions of weather, fuel moisture, soil moisture, etc., which allow the fire to be confined to a predetermined area while producing the intensity of heat and rate of spread required to accomplish the objectives of silviculture, wildlife-habitat management, grazing, fire-hazard reduction, etc.

**PREVENTION OF SIGNIFICANT DETERIORATION (PSD):** A program mandated by the Clean Air Act to prevent air-quality and visibility degradation, and to remedy existing visibility degradation. Before the construction of certain new pollution sources is approved, they must apply for and receive a PSD permit from the appropriate air-regulatory agency. The Forest Service has input into this PSD permitting process.

**SENSITIVE RECEPTORS:** Specific components of an air-quality-related value that may first exhibit human-caused change from air pollution. For example, in the Weminuche Wilderness, a sensitive receptor for visibility might be the view from Sun Light Peak to South River Peak. Potential human-caused changes to that view are changes in contrast, visual range, or coloration. A sensitive receptor for water may be Upper Grizzly lake; potential human-caused changes to it could affect pH, acid-neutralizing capacity, metals concentrations, other toxics, dissolved-oxygen concentrations, nutrients, or anion and cation concentrations. Table 2-1 lists potential human-caused changes to AQRV's and sensitive receptors.

**SMOKE MANAGEMENT:** Conducting a prescribed fire under fuel-moisture and meteorological conditions, and using firing techniques, that keep the smoke's impact on the environment within acceptable limits.

**SULFUR DIOXIDE (SO<sub>2</sub>):** A gas that is an efficient light-scatterer, thereby resulting in visibility degradation. It also can convert into acid droplets consisting primarily of sulfuric acid.

**UPPER-LEVEL WINDS:** The winds normally sampled at several specified heights above the earth's surface, often used to measure vertical temperatures for the determination of atmospheric stability. Also called geostrophic winds or winds aloft, these are the winds that transport pollutants long distances.



**VISIBILITY:** Conditions which allow the appreciation of landscape features: being able to see form contrast, detail, and the color of near and distant features.

**VISUAL RANGE:** The distance at which a large black object just disappears from view.

**VOC'S:** Volatile Organic Carbons, one of the precursors of ozone formation.

